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MEDICAL RESEARCH COUNCIL

RICKETS

The Relative Importance of Environment and Diet as Factors of Causation: an Investigation in London

BY

H. CORRY MANN, O.B.E., M.D.

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THE RELATIVE IMPORTANCE OF ENVIRONMENT AND DIET AS FACTORS OF CAUSATION: AN INVESTIGATION IN LONDON

BY

H. CORRY MANN, O.B.E., M.D.

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INTRODUCTION

During the summer of the year 1906, as physician to out-patients at the Evelina Hospital for Children in Southwark, London, I started an attempt to prevent the onset of rickets by means of a routine method of infant-feeding. The method which was adopted, and which was continued without intermission during eight years until the summer of 1914, was that of feeding throughout infancy with undiluted citrated milk. As every one knows who has employed this form of hand-feeding for babies, the plan is immensely successful, for fully 95 per cent. of the cases can be fed in this way provided that a certain caloric value for the total milk intake is used as a guide and that the milk feeds are not sweetened by additional cane sugar. Simplicity in the preparation of the feeds and avoidance of dirt contamination are additional advantages in dealing with children who live in poor homes and among slum surroundings.

The vast majority of babies who were fed by this method (*vide* Appendix 1) were found to be either of average or above normal weight and length at the age of 18 months, and they subsequently developed in normal manner. A certain number of the minority showed delayed ossification of the fontanelle, their teeth erupted at a later date than is usual, they were subnormal in size and in weight for age, but they did not develop rachitic deformities, the long bones remaining straight without enlargement of epiphyses, and by the age of seven or eight years, apart from subnormal height and somewhat thin bones, they were found to be healthy and active children (*vide* Appendix 2, T. G. and H. G.).

All the case papers had notes of total income, housekeeping money, the occupation of the wage-earners, rent and weekly charges for the home, the number of rooms occupied, type, and locality.

At that time I had no idea of publishing the notes, though three papers had already appeared in the *Guy's Hospital Gazette* dealing with the value of whole milk feeding in a poor district where casual labour is so common.

It was pointed out that the records would be of value in assessing the relative importance of environment and diet as causative factors in the production of rickets or scurvy, and when the Medical Research Committee started their programme of investigations I was asked to continue this work and to collect further data on the subject of rickets. A preliminary report was sent in dealing with 330 cases collected prior to March 1915, and details of diet and observations on home conditions were recorded.

The work was then interrupted by the war, as I proceeded on foreign service, but up to that time conditions had remained unchanged, both as regards food quality and food supply, and also as regards housing conditions. These earlier records, therefore, which are summarized separately (*vide* Appendix 3), refer to pre-war times, and except in a few instances no actual measurements were made of the rooms occupied, but I visited myself over 100 homes, making notes and drawing general conclusions as to environment. During the war the findings of Professor Noel Paton's workers in Glasgow were published (Med. Res. Com. Special Report No. 20), and stress was laid in that report upon the importance of air-space owing to the presence of 32 per cent. deficiency among rachitic as compared with non-rachitic families. There had been no obvious indication of such a deficiency among my own cases before the war—many of them were living in homes in the suburban outer ring of London, every house provided with a garden—but the point raised by the Glasgow workers could not be neglected, and since my work was resumed in London in April 1919 due attention has been paid to it, careful measurements have been taken of all the rooms occupied both by the families of the rachitic children and those of the healthy controls, so that the report of the London findings on this question could be compared accurately with that of Glasgow.

Methods of Investigation and Material.—The same type of schedule has been employed continuously, both before and since the war, but the details of housing conditions were enlarged so as to include in the later records the measurements of all rooms occupied by the families who were under observation—both rachitic and healthy.

The majority of the cases live in London on the Surrey side of the river within an area which extends eastward from Westminster Bridge for three miles to the Surrey Commercial Docks and southward from Southwark Bridge for 2½ miles, but as with the pre-war series certain of the families live in a much wider district, which is bounded by Dartford on the east (18 miles from London), by Ashford on the south (60 miles from London), and Surbiton on the west (12 miles from London).

A few cases come from the north side of the river, living in London boroughs, namely, Acton and Chiswick—west, Kilburn—north-west, Stoke Newington—north, Shoreditch, Whitechapel, Bethnal Green—east.

Most of these were attending as out-patients at the Evelina Hospital when first seen, another group are in attendance at various welfare centres in London, and a considerable number were attending the out-patient department at Guy's Hospital and were examined there by kind permission of the House Committee and Staff of the hospital.

The rickets cases which have been under observation have been divided into the following clinical groups :—

(1) Severe deformities with marked enlargement of the epiphyses.

(2) Slight deformities with prominence of the epiphyses.

(3) Prerachitic type—having delayed closure of the anterior fontanelle, delayed dentition, and X-ray changes typical of rickets at the epiphysial line.

(4) Delayed ossification without other signs of rickets.

The non-rachitic cases were obtained in the following way:—

(1) Healthy children—between the ages of 6 months and 15 months—first seen at their homes while a visit was being paid to another member of the same family.

(2) Babies born in the homes of rachitic children which were already under observation for the purpose of this inquiry.

(3) Healthy children—between the ages of 6 months and 15 months—who were found in the out-patient departments of the Evelina Hospital or of Guy's Hospital.

The non-rachitic cases were under observation for at least nine months, the great majority until the age of eighteen months, and very many until the age of two years. The new-born babies were under observation for at least twelve months, very many for eighteen months.

The details of the home and its environment have been obtained in a routine method both for the rachitic children and the non-rachitic by the same two lady visitors, who are expert in social work of this kind and who in addition are trained nurses with special knowledge of children's diseases, of massage, and of midwifery, for which they hold diplomas or certificates. They were each responsible for their own cases, and while keeping to the schedule made their reports, recording fully their impressions of the homes in their own words.

Clinical examinations were made by me both at hospital and at welfare centres. At the first visit to hospital a clinical examination and inquiry lasting at least half an hour was made; the mother or other guardian was then told the objects of the investigation and her co-operation was invited. Leading questions as far as possible have been avoided, and particular attention has been paid to voluntary statements both as to inherited methods of feeding and individual idiosyncrasies of diet among various members of a family, such statements being subsequently confirmed or amended at the home-visits or later visits to hospital. Whenever by reason of unemployment of the wage-earner or insufficiency of wages it was found that the income of the home was insufficient, either for general purposes or for a diet advised at hospital, immediate help was given with food until such time as the local agencies for relief could offer co-operation, recommendations for the latter assistance being provided by the visitor. Every possible effort was made to ensure that the visits were in every sense of a friendly character, that they were not regarded by the parents as inspections involving the possibility of censure, of the loss of lodgings or of tenants, or of prosecution in a magistrates' court, the visitors carefully disclaiming any such intentions. Furthermore, there was no attempt made to enforce the diet which had been ordered at hospital; it was very often found that, for various reasons, the treatment which had been advised there had not been carried out.

and care was taken to record the diet which was actually being used rather than to attempt any amendment on the lines which had been previously advised at the hospital clinic or welfare centre.

In a few instances where it was found that the visits were not appreciated or that the parents objected to the detailed inquiries into their home-life no attempt was made to continue them, and such information as was obtained has not been included in this report because of the possibility of the notes in question being unreliable. In the vast majority of cases the visitors were welcomed, and in a considerable number of instances where actual relief was supplied to necessitous families the parents, in return, gave active assistance to the investigations.

I. SOCIAL CONDITIONS.

A. Income.

The families which have been studied belong to the same social class in the great majority of cases, owing to the fact that the district in which most of the homes are situated is inhabited largely by wage-earners who are engaged in waterside or casual labour. For many of these during the winter months of the year unemployment is the rule rather than the exception, and during their period of unemployment they obtain relief in one of the following ways:

(*a*) By the use of savings made during that period of the year when employment is more regular.
(*b*) By pawning articles of furniture and clothing.
(*c*) By loans from relatives.
(*d*) By the income derived from married women's labour.
(*e*) By loans from local moneylenders, the usual rate being to borrow ten shillings at the beginning of the week and to repay ten shillings and ten pence at the end of the week.
(*f*) By the provision of fresh or dried milk either at half rates or free through the agency of Maternity or Infant Welfare Centres.
(*g*) By 'loan clubs'.
(*h*) By poor law relief in the form of food.
(*i*) By unemployment insurance pay—this last only in operation since the war.

During the first year of the investigation—April 1919 to April 1920—wages were tending to rise, and in some instances—e.g. the railway men and the dockers—there was a considerable rise. During the second year—April 1920 to April 1921—owing to increasing unemployment or to part-time work, to absence of overtime and also owing to an actual fall in wage, the tendency has been for the income to fall. These variations have been studied and allowance has been made for them in the case of families who have been under observation during the whole period of two years and a half.

During the last six months of the work, owing to the coal strike, there was a great increase in the number of families who were receiving relief both in the form of food and as unemployment pay, every industry being affected adversely. For this reason both income and diet became very variable; during one week both funds and food might be satisfactory, and during the next fortnight the family would be living on borrowed money or unemployment dole and food of poor quality.

Mr. T. W. Russell, Senior Clerk in the Statistical Department of the Medical Research Council, has taken a great deal of trouble in assessing the income per head and making averages of income where the wage was variable. These figures have been arranged under three headings: (1) Rickets with deformity. (2) Prerachitic cases—early signs. (3) Non-rachitic cases. *Vide* Table I. As some of the non-rachitic cases were born or living in homes where there were also rachitic children under observation, it has been thought advisable to include tables which deal only with 'Controls', that is to say, non-rachitic infants in whose homes no rachitic children were found. *Vide* Table II.

Figures are given for 324 cases of rickets and 273 non-rachitics (including 144 controls) for whom an accurate value could be placed.

In 70 cases of rickets and 58 non-rachitics (including 33 controls) definite information was either unobtainable or owing to irregular employment it was impossible to assess it.

These tables show first of all that both rachitic cases and controls have been drawn from the same industrial class, the three tables of income per head being very similar.

In London it is customary for the mother, out of her housekeeping allowance, to pay all charges under the headings of rent, fuel, including gas and coal, 'club' subscriptions, and insurance premiums. There is considerable variation in the weekly amounts so paid out, and owing to casual labour payments are often deferred by agreement until the wage-earner is again in full work. Such weekly payments for a family including four children would commonly average: Rent, 10*s.* Coal, 3*s.* 3*d.* Gas, 7*s.* 'Clubs', 2*s.* Insurance premiums, 2*s.* Total, 24*s.* 3*d.* (average in 1920).

It was found—both as a result of the investigation and from conversation with various social workers—that in such a family of four children with both parents alive, if the housekeeping money was 40*s.* weekly then the mother had the greatest difficulty in meeting her expenses—even in summer time—and the food was of poor quality, including condensed milk of a cheap brand.

This forty-shilling standard for a family of six has proved a reliable guide throughout the inquiry, for although the maximum index number was reached in April 1920 (total Index Number 352·9), the summit for food being in May 1920 (305·9) and for materials in March 1920 (386·9), there was little real fall in retail prices until December 1920, by which date the rise in rent values had almost reached the present level, so little relief for the housekeeper was actually experienced until June 1921, when, however, unemployment was widespread (Food values, &c., Index, *vide* Appendix 4).

	RICKETS. Housekeeping Allowance per Person.			PRERACHITICS (EARLY SIGNS). Housekeeping Allowance per Person.			NON-RACHITICS (*vide* paragraph 2, p. 10.) Housekeeping Allowance per Person.		
Income per Head.	*Work Regular. Cases.*	*Casual or Unemployed. Cases.*	*Father deserts mother, unknown or dead. Cases.*	*Work Regular. Cases.*	*Casual or Unemployed. Cases.*	*Father deserts mother, unknown or dead. Cases.*	*Work Regular. Cases.*	*Casual or Unemployed. Cases.*	*Father deserts mother, unknown or dead. Cases.*
1/-	...	...	...	...	...	...	...	1	...
2/-	...	...	...	...	1	...	...	1	...
3/-	...	...	...	...	...	...	1	5	...
4/-	3	3	...	...	1	...	3	3	...
5/-	17	12	1	...	...	...	3	11	...
6/-	10	8	1	2	1	...	15	14	1
7/-	16	6	2	3	2	...	16	8	1
8/-	22	22	3	7	2	...	22	11	...
9/-	10	3	1	2	1	...	15	6	...
10/-	15	6	2	5	5	...	21	12	1
11/-	23	3	3	2	1	1	14	4	4
12/-	17	3	2	2	...	...	19	3	2
13/-	12	8	1	3	1	...	15	5	1
14/-	2	3	...	3	...	...	8	...	...
15/-	7	...	2	3	1	...	10	1	...
16/-	3	...	...	3	2	...	2	...	1
17/-	1	3	...	...	...	...	1	...	1
18/-	2	...	...	...	1	...	1	...	...
19/-	1	...	...	...	...	...	1	...	1
20/-	4	...	...	1	...	...	6	1	...
21/-	...	...	...				2	...	...
22/-	1	...	1				...	...	...
23/-	...	...	...				...	...	...
24/-	1	...	...				...	...	...
25/-	...	...	...				...	...	1
26/-	1	...	...				...	...	...
27/-	1	...	...				...	...	...
28/-	...	...	...				...	...	1
Totals	169	80	19	36	19	1	175	86	12

Insufficient Particulars of Housekeeping Allowance. (Rickets)

Old cases, figures uncertain	8
No particulars	5
Regular work, wages not stated	27
Casual work, insufficient information	22
Dead	2
Total	64

Insufficient Particulars of Housekeeping Allowance. (Prerachitics)

Regular work, wages not stated	2
Casual work, insufficient information	4
Total	6

Insufficient Particulars of Housekeeping Allowance. (Non-Rachitics)

No particulars	6
Regular work, wages not stated	25
Casual work, insufficient information	26
Dead	1
Total	58

It will be noticed that below the level of income six shillings per head (*vide* Tables I and II) there are 38 rickets cases and 13 control cases. All of these 13 control cases, however, were attending Infant Welfare Centres and in receipt of 'invisible assets' in the form of fresh milk or dry milk at 'special rates' or possibly a 'free supply' for considerable periods.

Of 30 cases—controls—which are at the six shillings per head level a considerable number were obtaining the same advantages, which meant that a pound of dried milk could be obtained at the price of 2*s.* or 2*s.* 3*d.* per pound as against the price of 3*s.* or 3*s.* 3*d.* per pound in the open retail market, or the supply was 'free'.

There has been widespread evidence of the immense importance of this scheme of milk distribution as a preventive factor of rickets for these control cases of necessitous families many of which include cases of rickets among the older children.

The rachitic child, on the other hand, does not frequent Welfare Centres, and the cases of rickets which arise among infants who remain under the regular supervision of a Welfare Centre are very few in number, other factors being responsible for failure.

TABLE II. *Controls* (*vide* paragraph 2, page 10.)

Showing condition of Father's employment and Housekeeping Allowance.

Income per Head.	*Regular. Cases.*	*Casual. Cases.*	*No particulars of employment. Cases.*	*Total Cases.*
3/-	3	10	–	13
6/-	18	16	2	36
9/-	33	9	1	43
12/-	24	5	1	30
15/-	8	1	2	11
18/-	6	1	–	7
21/- +	2	–	2	4
No particulars of Housekeeping Allowance	13	14	6	33
Total	107	56	14	177

B. RENT.

During the period of two and a half years under review the rents of tenements and lodgings have increased by 50 to 60 per cent. These increases took place more especially during the year 1920, for when work on rickets was resumed in April 1919 the rents which were then paid were almost the same as before the war, although there had already been a considerable rise in wages, and local rates had already increased.

The following details refer to a typical Southwark home:

A two-story house of nine rooms and two sculleries—occupied by three families—seventeen persons in all, one family living on each floor. The family who are under observation have three rooms and a scullery on the second floor. They have lived there for thirty years, within half a mile of London Bridge. Rooms:

Kitchen. NW. 10 ft. 6 in. × 7 ft. 10 in. × 7 ft. 10 in. height.
One window 2 ft. 10 in. × 4 ft. 2 in.

Scullery. NE. 6 ft. 0 in. × 4 ft. 3 in. × 7 ft. 10 in. height. One window 2 ft. 2 in. × 3 ft. 8 in.

W.C. Off scullery. Window ventilation 1 ft. × 1 ft.

Front bedroom. WSW. 12 ft. 4 in. × 13 ft. 0 in. × 7 ft. 10 in. height. Two windows 3 ft. 5 in. × 4 ft. 3 in. each. A sunny room. Grandmother and three children sleeping in.

Back bedroom. NE. 11 ft. 6 in. × 8 ft. 6 in. × 7 ft. 9 in. height. Window 3 ft. 2 in. × 4 ft. 2 in. Grandfather and uncle sleeping in.

Front. Side street of average width. Open at both ends. Airy, not enclosed.

Back. A yard with fowls, and back premises and yards of other houses.

Remarks. Good rooms. Clean. Through ventilation, back to front.

Rent in 1891	6*s.* 6*d.*	weekly.
„ „ 1919	7*s.* 6*d.*	„
„ Xmas 1920	11*s.* 4*d.*	„
„ July 1921	11*s.* 10*d.*	„

C. Housing.

The almost complete absence of empty houses and flats for working-class people as a result of the cessation of house-building operations during the war had the effect of maintaining housing conditions in an unchanged state while the investigation has been in progress. In fact, very little house-moving indeed has taken place during the past two years, and it has therefore been possible to watch the development of both rachitic children and controls living side by side in the same streets, in the same houses, and even in the same rooms over a prolonged period and under unchanged conditions of air-space and environment which would not have been found before the war.

Strange as it may seem in view of a widespread opinion as to the prevalence of overcrowding in poor districts, an opinion which has been freely disseminated by the press, we have found little indication of gross overcrowding among the homes visited, and nothing approaching the standard of congestion which has been suggested as prevalent. In most of the houses, inhabited in many cases by two or more families, the index of population stands at that of two persons per room, and in many instances it is lower. It may be said that the absence of empty houses has produced inconvenience for the labouring classes rather than insanitary conditions.

As a result of previous medical and social work during a period of twenty-one years in the district in question, and comparing especially the pre-war with the post-war conditions, the following conclusions may be drawn:

(*a*) Housing shortage at the present time produces an economic disability in that a labourer is not able to live near his work and to move into a new district with a change of labour to that district. This results in money being spent on travelling to work which would otherwise be spent on food.

(*b*) Children of opposite sexes above the age of puberty are sleeping in the same rooms.

(*c*) Young married couples have been compelled to remain living with their parents, being unable to find new rooms.

(*d*) Before the war it was exceedingly common to find in the homes of families of this class a parlour or sitting-room in addition to a kitchen. This room has disappeared, as it is probably occupied by a lodger or other tenant, and as a result the furniture and household belongings of three or four rooms are now crowded into the floor space provided by only two or three rooms, and the latter overcrowded rooms are sometimes imperfectly cleaned on this account.

Housing details have been collected under the following headings:

Table III. Type of dwelling. This return shows that rachitic children and non-rachitics are living in similar surroundings and in quarters of the same class, about 60 per cent. of each occupying rooms in one- or two-story houses which line the usual variety of side street.

Table IV and IV A. Total air-space of the rooms, flat, tenement flat, or house occupied. This return shows that the conditions are almost identical, complete records having been made for about 360 cases of rickets and 310 non-rachitics. In some of the homes of the non-rachitics other rickety children were found; a separate table is therefore shown dealing with 'Controls', that is to say, non-rachitic children in whose families there were no rachitic subjects (Table IV A.)

Table V and V A. This return gives details of the air-space per person of the bedroom in which the rachitic or non-rachitic child was sleeping.

The 'Controls' are tabled separately (Table V A).

The three series of figures—percentages—are very similar.

45 per cent. of rachitic cases, 44 per cent. of non-rachitics, and 38 per cent. of controls have less than 300 cubic feet per person.

Table VI. The size of the family. The number of children born. There are no differences of note. The number of children born is smaller than was found to be the case in the studies upon rickets which were made in pre-war years (330 cases).

In 53 per cent. of the rachitic cases and in 55 per cent. of the non-rachitic only three children had been born.

There has been considerable evidence that measures to prevent conception or to procure abortion are practised more commonly than was the case prior to the war, and the statement was made not infrequently that income would not permit of increase in the size of the family. A further reference is made to this point under the

TABLE III. *Type of Dwelling.*

	Rickets. *Cases.*	Prerachitics. *Cases.*	*Total of Rickets and Prerachitics.*	*Per cent.*	Non-rachitics. *Per cent.*	Non-rachitics. *Cases.*	Controls. *Number of Cases.*	Controls. *Per cent.*
I. Rooms in a house	197	42	239	60	66	219	124	70·1
II. Flat	31	3	34	8	9	31	15	8·5
III. Tenement Flat	66	10	76	19	15	51	22	12.4
IV. Small House	32	7	39	10	8	7	14	7.9
V. Insufficient Information	6	...	6	1.5	0.9	23	2	1.1
Totals	332	62	394			331	177	

TABLE IV. *Air space of Rooms per Person.*

Air space per person in cubic feet.	Rickets. *Cases.*	Prerachitics. *Cases.*	*Total.*	*Per cent.*	Non-rachitics. *Per cent.*	Non-rachitics. *Cases.*	Delayed Ossification *Cases.*
100	3	1	4	1	1.8	6	1
200	23	3	26	6·6	6·6	22	...
300	66	8	74	18	20	68	2
400	56	13	69	17	19·8	66	2
500	48	8	56	14	11·7	39	...
600	40	6	46	11	10·8	36	1
700	19	8	27	6·8	6·3	21	...
800	18	6	24	6	5·1	17	1
900	12	2	14	3·5	3	10	...
1,000	8	2	10	2·5	1·5	5	...
1,100	1	2	3	...	...	10	...
1,200	5	...	5	...	...	2	...
1,300	6	...	6	...	...	5	...
1,400	2	...	2	...	...	1	...
1,500	1	...	1	...	...	1	...
1,600	...	1	1	...	...	...	...
1,700	...	...	...	...	...	1	...
1,800	...	...	...	...	...	...	...
1,900	...	...	...	...	...	...	...
2,000 and upwards	...	...	...	...	...	1	...
Insufficient Information	24	2	26	...	...	20	...
				...	...		
Totals	332	62	394	...	...	331	7

TABLE IV A. *Air-space of Rooms per Person.*

Cubic feet.	CONTROLS. *No.*	*Per cent.*	RICKETS. *No.*	*Per cent.*	NON-RACHITICS. *No.*	*Per cent.*
200	41	23·2	104	26·3	96	29.0
400	49	27·8	125	31·7	105	31·7
600	42	23·2	73	18·5	57	17·2
800	19	10·8	38	9·6	27	8·1
1,000	10	5·6	13	3·3	15	4·5
1,200	5	2·8	11	2·7	7	2·1
1,400	2	1·1	3	0·7	2	0·6
1,600	2	1·1	1	0·2	2	0·6
No particulars	7	3·9	26	6·6	20	6·0
Totals	177	99·5	394	99·6	331	99·8

TABLE V. *Air-space per Person in Cubic Feet of Sleeping Room.*

Air-space of Sleeping Room per Person in Cubic Feet.	RICKETS. *Cases.*	PRERACHITICS. *Cases.*	*Total.*	*Per cent.*	NON-RACHITICS. *Per cent.*	NON-RACHITICS. *Cases.*	DELAYED OSSIFICATION. *Cases.*
0	3	...	3	0·7	...	...	...
100	49	8	57	14·4	11	39	2
200	98	20	118	30	33·2	110	2
300	76	17	93	23·6	26	86	2
400	37	10	47	11·9	12	40	1
500	16	4	20	5	5·7	19	...
600	8	1	9	2·2	1·8	6	...
700	2	...	2	...	...	5	...
800	5	...	5	...	...	4	...
900	3	...	3	...	...	...	...
1,000	3	...	3	...	...	...	...
1,100	2	...	2	...	..	...	...
Insufficient Information	30	2	32	...	...	22	...
Totals	332	62	394			331	7

TABLE V A. *Air-space of Sleeping Room per Person.*

	Controls.		Rickets.		Non-rachitics.	
Cubic feet.	*No.*	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*
100	14	7·9	60	15·1	39	11.4
200	53	30·1	118	30.0	110	33.2
300	57	31.8	93	23·6	86	26·0
400	24	13.6	47	11·9	40	12·0
500	12	6·8	20	5·0	19	5.7
600	3	1·7	9	2·2	6	1·8
700	5	2·8	2	0·5	5	1.5
800	4	2·2	13	3.3	4	1·2
No particulars	5	2·8	32	8·0	22	6·6
Totals	177	99·7	394	99.6	331	99.4

TABLE VI. *Size of Family—Number of Children Born.*

Number of Children Born.	Rickets. *Cases.*	Prerachitics. *Cases.*	*Total.*	*Per cent.*	Non-rachitics. *Per cent.*	Non-rachitics. *Cases.*	Controls. *Cases.*	Controls. *Per cent*
1	43	13	56	14	15	50	43	24·3
2	69	17	86	21·8	25	85	41	23·2
3	57	14	71	18	15·7	52	23	13·0
4	34	6	40	10	16	53	27	15·3
5	32	5	37	9·3	5·7	19	11	6·2
6	25	3	28	7	5·7	19	10	5·6
7	19	2	21	5·3	3·9	13	8	4·5
8	23	...	23	5·9	4·5	15	6	3·4
9	8	...	8	2	2·7	9	4	2.3
10	11	...	11	2	2·4	8	1	...
11	1	...	1	...	...	1	...	...
12	2	...	2	...	...	2	1	...
13	1	...	1	...	...	1	1	...
14	5	1	6	...	...	1	...	...
15	...	...	...	...	...	1	...	...
16	...	1	1	...	...	...		...
Insufficient Information	2	...	2	...	...	2	1	...
Totals	332	62	394			331	177	

TABLE VII. *Size of Family—Number of Children Living.*

Number of Children Alive.	RICKETS. *Cases.*	PRERACHITICS. *Cases.*	*Total.*	*Per cent.*	NON-RACHITICS. *Per cent.*	NON-RACHITICS. *Cases.*	CONTROLS. *Number of Cases.*	CONTROLS. *Per cent.*
1	46	19	65	16·5	19·0	63	56	31·6
2	82	14	96	24·4	27·5	91	38	21·4
3	71	20	91	23·0	19·3	64	33	18·6
4	30	3	33	8·3	12·0	40	19	10·7
5	29	2	31	8·0	6·6	22	13	7·3
6	34	3	37	9·3	6·6	22	11	6·2
7	23	...	23	5·9	3·9	13	4	2·2
8	9	...	9	2·2	2·1	7	...	...
9	2	...	2	...	...	2	1	...
10	4	...	4	..	...	4	1	...
11	...	...	...	...	...	1	...	...
12	.	1	1	...	...	...	...	...
Insufficient Information	2	...	2	...	...	2	1	...
Totals	332	62	394			331	177	

Note. In 72·2 per cent. of the Rachitic cases, in 77·8 per cent. of the Non-rachitic cases, and in 82 per cent. of the Control cases, the families do not consist of more than four children.

TABLE VIII. *Condition of Father's Employment.*

Father.	RICKETS. *Cases.*	PRERACHITICS. *Cases.*	*Total.*	*Per cent.*	NON-RACHITICS. *Per cent*	NON-RACHITICS. *Cases.*	CONTROLS. *Number of Cases.*	CONTROLS. *Per cent.*
Regular Work	196	38	234	59	60	200	107	60·4
Casual or Unemployed	102	23	125	31·7	32·9	109	57	32·2
Dead	14	1	15	3·8	1·5	5	...	..
Insufficient Information	20	...	20	5	4·5	15	13	7·3
On Strike	...	...	...	...	...	2	...	...
Totals	332	62	394			331	177	

TABLE IX. *Condition of Mother's Employment.*

Mother.	RICKETS. *Cases.*	PRERACHITICS. *Cases.*	*Total.*	*Per cent.*	NON-RACHITICS. *Per cent.*	NON-RACHITICS. *Cases.*	CONTROLS. *Number of cases.*	CONTROLS. *Per cent.*
Living at home	219	43	262	66·5	78·1	257	130	73·4
Dead	...	1	1	...	...	2	2	1·1
Continuous work	31	5	36	9·1	5·1	17	12	6·8
Occasional work	23	3	26	6·6	3·3	11	7	4·0
Prior to case	16	5	21	5·3	2·1	7	6	3·4
Prior to case and during pregnancy	5	1	6	1·5	...	...	...	...
During and prior to case	11	2	13	3·3	3·0	10	4	2·3
During, prior to case, and during pregnancy	1	...	1	...	...	3	2	1·1
During case and pregnancy	8	1	9	...	...	8	2	1·1
During pregnancy	8	1	9	2·2	3·9	13	8	4·5
Insufficient information	10	...	10	...	...	3	4	2·3
Totals ...	332	62	394	...	...	331	177	

heading of 'Ante-natal deficiencies' with regard to the incidence of rickets.

Table VII. Number of children alive.

There are no differences of note to be observed between the two groups. In both instances the families are smaller than in pre-war days.

Table VIII. Nature of father's employment.

There are no differences to be observed between the two groups, but it should be mentioned that under the heading of 'regular work' are many instances in which the labourer is working 'part time' owing to the trade depression which began in October 1920.

Table IX. Occupation of mother.

The advantage rests with the non-rachitic cases in that the mother in nearly 80 per cent. is living continuously at home, whereas with the rachitic cases in only 66 per cent. was she living at home. In ten other instances there was a good deal of evidence to give rise to suspicion that her constant attention was not given to the care of a rachitic child, but definite information could not be obtained.

'Controls' have been tabled separately in all the above tables.

D. Fresh air and Exercise.

There has been no indication that the rachitic cases as distinct from the controls have suffered to a greater degree from the want of fresh air.

Absence of fresh air and sunshine lead to anaemia in a child who is kept at home, and the marked pallor is recognized at once. Moreover, 60 per cent. of the families who have been under observation occupy rooms in rows of small houses mostly of one or two stories which line side streets not subject to heavy traffic. The street is the playground for all ages, and as the climate of London is mild usually for at least eight months of the year, the habit of the child is to be in the roadway rather than in the house. It is perhaps only on the upper stories of high tenement buildings that any tendency has been observed to keep children indoors. Many rachitic children can be found in summer-time with sunburnt faces. As soon as the family possesses a child of ten they become great wanderers, and Southwark out-patients—*in loco parentis* complete with babies—have been found in Hyde Park, over two and a half miles from their homes, during fine weather.

Anaemia undoubtedly delays recovery from rickets, and even with an adequate diet improvement is slow or delayed for those who are cursed with the misfortune of a mother engaged in married women's labour.

E. Distinctions of Race.

The particular area of London which has been the district where by far the greater part of the investigation has been made is inhabited almost entirely by people of British and Irish stock, there being a considerable percentage of the latter. Six Italian families, one Dutch, and ten Hebrew have been the only foreign element. The South waterside differs in this matter very much indeed from the East End of London, though in one street of Rotherhithe which borders the Surrey Commercial Docks may be seen the fair-haired and blue-eyed Scandinavian type whose fathers are sometimes unknown sailors from the Norwegian timber ships.

Racial characteristics must not be forgotten, for it is possible that the small and slowly-growing infant of southern Italy or Malta is more easily protected from and less prone to develop rickets than the larger and more rapidly-growing child of a more northern climate.

II. THE HEALTHY NON-RACHITIC AND THE RACHITIC CHILD

A comparative study has been made of the methods of feeding adopted for the healthy children employed as 'control' cases, and for the rachitic children up to the age when signs of rickets first appeared.

For both groups of cases a considerable percentage show certain dietetic features which are constantly recurring throughout the series, and if careful notes are taken of individual diets, of the family diet sheet, and of the housekeeping portion of the total wage upon which the quality of the food on the table depends, such findings would be the experience of any one working at a children's hospital in any large town.

The quality of the diet is bad and the fat-carbohydrate balance of the diet is wrong more often as a result of money shortage than of ignorance and careless feeding. That cases of rickets do occur under other circumstances, under conditions where the home is well found and comfortable is undoubted, but they are relatively infrequent if the investigation includes all classes of industrial life in a wide area.

The cases have, therefore, been grouped under headings indicative of causative factors in order to show the percentage incidence.

In reviewing the dietary I have not adopted the family budget system which was used by Miss Margaret Ferguson in Glasgow. This system is a method which may be of value in studying the industrial diets of adults, but when dealing with children the conclusions may be fallacious, more especially when those children, as in the case of rickets, are between the ages of six months and two years. Children are quite peculiar in their individual likes and dislikes in matters of food, and individual members of a family often show rooted objections to certain items of diet. These idiosyncrasies are nearly always conquered as the child passes beyond the fifth birthday, but in some children in spite of disciplinary measures they remain throughout life, and this may be due to failure in assimilation of certain forms of protein, carbohydrate, or fat. I myself was an elder member of a family including eight children, and I well remember how very much the individual members as children differed as regards the quality of food eaten. In many such cases conclusions based upon a 'family budget' of diet are bound to be misleading. Furthermore, rickets is a complaint which shows itself by symptoms appearing during a certain dietetic period in a child's life, namely, between six months and eighteen months; cases which occur earlier or later than this age period are rare. During that period is the change from liquid to solid food. In most cases the change occurs without incident—the baby often taking a personal interest in hastening the alteration. But whereas the child takes readily almost without exception to solid forms of carbohydrate, especially potato, sugar and bread, there is often an interval before the change from liquid milk fat to solid meat fat, such as dripping, is allowed by the baby, and in some instances the interval extends to a matter of years. Again, even in the quality of solid fat and in the method of cooking marked idiosyncrasies are shown at this period of life. As a general rule fats which tend to liquefy at ordinary air temperature are taken more readily, and the lower the melting-point the better they are tolerated. Digestive failures are responsible for some differences, and such failures are sometimes forgotten, undue importance being attached to the presence of a 'vitamin' rather than to the digestive powers of the individual for a particular article of food.

These discrepancies in the quality of the diets do not appear when only family budgets of food are studied, and for the above reasons I have not followed the Glasgow method of investigation, but each family has been carefully worked through, the individual peculiarities of each child, and often of the parents as well, have been recorded both for healthy controls and for the cases of rickets.

Tables have been drawn up indicating the type of diet employed for the non-rachitic and rachitic cases. The classification has been arranged under twelve headings on broad lines without any detailed particulars as to the quality of the food and the length of time during which the diet was employed, the main features only being indicated, but approximately the length of time of feeding under the different categories is the same. For full details see the tables concerned.

The non-rachitic cases have been subdivided into:

(1) Controls, whose homes were visited repeatedly. Measurements of the rooms and details of the environment were recorded.

(2) Other non-rachitic cases who were under constant supervision, but the rooms of the home were not measured and the details of the house were incomplete.

(3) Non-rachitic cases born in families where one or more rachitic children were already under observation, with records of the home conditions. These are entered in a separate table (*vide* p. 31).

These tables show that when the matter is considered without any detailed examination there are obvious differences between the rachitic babies and the non-rachitic babies. Only 31 per cent. of the former and 77 per cent. of the latter have been fed upon breast-milk, fresh milk, or dried milk.

Such findings authorize the further examination of both non-rachitic and rachitic cases in detail in so far as the methods of feeding are concerned.

Non-rachitic Cases. 242.

	(*a*) *Controls.*	(*b*) *Other non-rachitics.*	*Totals.*	*Per cent.*	
1. Breast-feeding . . .	31	13	44	18.1	77.8 per cent.
2. Breast and fresh milk .	52	14	66	27.2	
3. Breast and dried milk .	32	18	50	20.6	
4. Fresh milk . . .	8	Nil	8	3.3	
5. Dried milk . . .	11	Nil	11	4.5	
6. Dried and fresh milk .	8	Nil	8	3.3	
7. Fresh milk and foods .	1	1	2	0.8	
8. Condensed sweet milk .	4	2	6	2.4	21.6 per cent.
9. Breast and condensed milk	10	12	22	9.0	
10. Breast-milk with foods .	4	2	6	2.4	
11. Mixed methods . . .	16	3	19	7.8	
12. War shortages . . .	...	...	...	...	
Totals	177	65	242		

Rickets. 533 *Cases.*

	Totals.	*Per cent.*	
1. Breast-feeding	59[1]	11.0	31·4 per cent.
2. Breast and fresh milk . .	54	10.1	
3. Breast and dried milk . .	16	3.0	
4. Fresh milk	16	3.0	
5. Dried milk . . .	2	0.3	
6. Dried and fresh milk . . .	3	0.5	
7. Fresh milk and foods . . .	19	3.5	
8. Condensed sweet milk . .	61	11.4	68.1 per cent.
9. Breast and condensed milk .	101	18.9	
10. Breast-milk and foods . .	7	1.3	
11. Mixed methods[2]. . . .	120[3]	22.5	
12. War shortages	75	14.0	

[1] Includes 37 cases of feeding with poor breast-milk (see page 46).

[2] Mixed methods. The diet was at first good and the baby made progress; subsequently the method of feeding was changed and the food was of poor quality with little fat and excess of carbohydrate.

[3] Includes 51 cases of prolonged breast-feeding with a diet of poor quality (see page 47).

III. NON-RACHITIC CASES

Total 428 + 8 = 436.

These have been arranged in three main groups:

A. Cases which from the first were regarded as healthy children and were supervised as such, coming under observation at various ages from birth to 18 months—mostly between the ages of 6 months and 12 months.

These have been subdivided into two groups:

(1) True controls—the homes of which were studied in detail (177 cases).

(2) Other non-rachitics (65 cases) . . . *Total* 242 cases

B. Cases which were born in families where one or more rachitic children were already under observation . . . . *Total* 186 cases

C. Non-rachitic cases developing rickets . . *Total* 8 cases

The methods of feeding which were employed for the various cases in these three groups will now be described in detail.

A. NON-RACHITIC CASES. SELECTED AS HEALTHY BABIES WITHOUT SIGNS OF RICKETS.

242 cases.

Methods of feeding—35. Thus:

1.	Breast-feeding to 8 or 9 months of age, then ordinary food including one pint of fresh milk minimum		57 cases.
2.	Breast-feeding for short periods, then 'Glaxo' or 'Ambrosia', then fresh milk and a diet with adequate fat		42 cases.
3.	Breast-feeding to 12 months of age, very little food otherwise up to that date		40 cases.
4.	Breast-feeding for short periods with fresh milk or dried milk, then fresh milk or dried milk (six methods)		33 cases.
4 *a*.	Breast-feeding with occasional feeds of fresh milk, later 'Ambrosia' (or 'Glaxo')	8 cases.	
4 *b*.	Breast-feeding, then citrated whole fresh milk and malt	4 cases.	
4 *c*.	Breast-feeding, then fresh milk and barley water or fresh milk and groats	6 cases.	
4 *d*.	Breast-feeding with 'Glaxo', then Benger's food with fresh milk, later fresh milk alone and a satisfactory diet	4 cases.	
4 *e*.	Breast-feeding, then 'Glaxo', then Nestlé's sweet milk, then fresh milk	10 cases.	
4 *f*.	Breast-feeding with a fresh milk-cream-sugar mixture	1 case.	
		(Total 33 cases).	
5.	Breast-feeding to 9 or 12 months of age with additional feeds of Nestlé's sweet milk and a general diet afterwards with adequate fat (three methods)		20 cases.
5 *a*.	Breast-feeding to 12 months of age, with occasional feeds of Nestlé's sweet milk	8 cases.	

5 *b*. Breast-feeding to 10 months of age, then Nestlé's sweet milk and a general diet with dripping. Weaned at about the age of 12 months	11 cases.	
5 *c*. Breast-feeding alone to 6 months of age, then breast-milk with alternate feeds of Nestlé's sweet milk to 9 months, then fresh milk ℥xx daily and the house diet of variable quality	1 case.	
	(Total 20 cases).	
6. Breast-feeding for short periods with patent foods and fresh milk as extra feeds (five methods)		8 cases.
6 *a*. Breast-feeding with additional feeds of fresh milk and Allenbury No. 3 food, then citrated whole unsweetened fresh milk	4 cases.	
6 *b*. Breast-feeding to 6 months, then extra feeds of fresh milk and Neave's food to 10 months of age, thereafter an adequate diet with fresh milk	1 case.	
6 *c*. Breast-feeding to 3 months of age, then fresh milk with Ridge's food to the age of 10 months, then an ordinary diet with ℥xx fresh milk daily	1 case.	
6 *d*. Breast-feeding with 'Glaxo' to the age of 6 weeks, then fresh milk and barley water, then fresh milk ℥xx daily, malt and Ridge's food, then an ordinary house diet with ℥xx fresh milk	1 case.	
6 *e*. Breast-milk feeding with diluted fresh milk to the age of 5 weeks, then Allenbury No. 1 and No. 2 foods until the age of 6 months, then Allenbury No. 2 with fresh milk ℥xxv daily to the age of 7 months, then citrated fresh milk, undiluted and unsweetened	1 case.	
	(Total 8 cases).	
7. Breast-feeding, then Nestlé's sweet milk, then a general diet including dripping and fresh milk (four methods)		9 cases.
7 *a*. Breast-feeding to 3 months of age, then Nestlé's sweet milk from 3 to 12 months of age, then an adequate diet with fresh milk	6 cases.	

7 *b.* Breast-feeding was given throughout to the age of 24 months, dripping with other food was started from the age of 10 months, and Nestlé's sweet milk from 14 months, after which age a good diet was given with little breast-milk . . . . . 1 case.

7 *c.* Breast-feeding to the age of 6 weeks, then Nestlé's sweet milk to 8 months, then skim condensed milk (Goat brand) and a diet including dripping to 20 months, then fresh milk and an adequate diet . . . . . 1 case.

7 *d.* Breast-feeding to 6 weeks of age, then Nestlé's sweet milk to 8 months of age, then fresh milk and an adequate diet . . . . . 1 case.

(Total 9 cases).

8. Fresh milk and dried milk (six methods) . . . 20 cases.

8 *a.* Fresh milk and barley water to 8 or 12 months of age, then an adequate diet with fresh milk, ℥xx daily . 8 cases.

8 *b.* 'Glaxo', then citrated whole milk unsweetened . . . . . 2 cases.

8 *c.* 'Glaxo' throughout the first year, and then continued with an adequate diet. . . . . . . 5 cases.

8 *d.* 'Glaxo' to the age of 9 months, then fresh milk and groats and an adequate diet . . . . 3 cases.

8 *e.* Citrated whole fresh milk unsweetened, then 'Ambrosia' and an adequate diet . . . . . . 1 case.

8 *f.* Fresh milk, then 'Glaxo' and an adequate diet subsequently with 'Glaxo', one pound weekly . . 1 case.

(Total 20 cases).

9. Fresh milk, adequate quantities with Savory and Moore's food to the age of 12 months, then an adequate diet with fresh milk, one pint (minimum) daily . 1 case.

10. 'Glaxo' adequate to the age of 8 months, then fresh milk ℥x daily with additional feeds of Nestlé's sweet milk and an ordinary house diet of variable quality in an industrial home of poor station . . . 1 case.

11. Néstle's sweet milk for various periods, then 'Glaxo' or fresh milk and an adequate diet (six methods) . 11 cases.

11 *a.* Nestlé's sweet milk to 4 months of age, then 'Glaxo' to the age of 12

	months, and an adequate diet afterwards with 'Glaxo' or fresh milk .	3 cases.
11 *b*.	Nestlé's sweet milk to 3 months of age, then Nestle's sweet milk with fresh milk ℥xv daily to the age of 10 months, then an adequate diet including dripping, bacon fat, and ℥x fresh milk daily	1 case.
11 *c*.	Nestlé's sweet milk with olive oil (ʒj was added to each bottle) to the age of 12 months, then a general diet with Nestlé's sweet milk . .	1 case.
11 *d*.	Nestlé's sweet milk and butter with barley water to the age of 7 months, then 'Glaxo' and an adequate ordinary house diet . . .	1 case.
11 *e*.	Nestlé's sweet milk to 8 months of age, then fresh milk and an adequate diet	3 cases.
11 *f*.	Nestlé's sweet milk to 8 months of age, then an adequate diet, including fats, and Nestlé's sweet milk . .	2 cases.
		(Total 11 cases).

Note.—In fifteen cases, among 242 non-rachitics, the mother was engaged in married women's labour.

The following are additional details from certain of the above case-papers which present interesting or unusual features:

Method 2. A. F. No. 111. Baby boy, sixteen months: weight 17 lb. 4 oz. Breast-feeding alone to the age of seven months, when the child was weaned with the advice of the Welfare Centre and fed by 'Glaxo' to the age of ten months, after which date he received a pint of fresh milk daily with a general diet to which cod liver oil ʒiij daily was subsequently added. He was a 'backward' child in many ways. Dentition delayed—4 teeth at sixteen months, 7 teeth at twenty months, and subnormal in height and weight for age. He did not develop even early X-ray signs of rickets. He suffered from epidemic diarrhoea at nine months (September 1919) and measles with bronchitis at eleven months. The parents after his birth were under treatment for syphilis, receiving injections of N.A.B. In October 1919 the mother had a miscarriage.

Method 3. L. M. No. 207. Baby girl. Breast-feeding alone to the age of twelve months, and continued until the age of fifteen months with an adequate fat diet including butter. After that date the diet included margarine, occasionally dripping, and one pint (average) of fresh milk daily. She was small-weight for age at fifteen months, but improved considerably after fifteen months of age, until at $2\frac{3}{12}$ years the height was 33 in. and weight 23 lb. 8 oz. Dentition was delayed—14 teeth only at two years. The fontanelle had closed at twenty-one months. During the second year she received ʒiij cod liver oil daily for about four months. No signs of rickets were found at any time.

G. P. No. 381. Baby girl. Breast-feeding alone to the age of nine months, and subsequently continued to the age of fourteen months with adequate fat in the diet. After that age the diet included half a pint of milk daily in tea (not a very thirsty child), and dripping at least three times weekly, as the child was 'very fond of it and would eat it in handfuls'. During the first year the mother often gave the child bacon fat to suck 'as is her practice with all her children', and bacon fat was not discontinued during the second year. No signs of rickets developed, and there have been no cases among nine children who have all been fed in the same way. G. P. walked at ten months. Dentition—first two teeth at four months. Twenty teeth at two years. Fontanelle closure at eighteen months. Weight 24 lb. 6 oz. at two years and height $32\frac{1}{4}$ in. Stem height, 19 in. The home is a poor one. Income 78*s.* weekly for parents and nine children, two boys helping. Rent, 8*s.* weekly, 'standing', for four rooms. Fourteen years in residence. Insurance 2*s.* weekly, coal 3*s.* 6*d.* weekly, gas 3*s.* 3*d.* weekly. One room let at 3*s.* Total: Thirteen persons in five rooms and a wash-house. Five children are sleeping in one bed in a room 10 ft. 11 in. × 8 ft. × 7 ft. 6 in. height. Window: 2 ft. 8 in. × 4 ft. 2 in.

Method 4 d. The four cases in this sub-group were all cases of primary infantile dyspepsia, who were hospital in-patients and out-patients for some months, receiving special forms of food such as peptonized milk and Benger's food, both of which preparations were valuable owing to digestive troubles in the early months of life. They eventually made satisfactory progress, fat percentage being gradually increased as tolerance for milk improved. Signs of rickets did not develop.

G. P. No. 342. Baby boy. 10 lb. 4 oz. at four months, 9 lb. 4 oz. at six months, 10 lb. 6 oz. at seven months, 11 lb. 5 oz. at eight months, 13 lb. 11 oz. at nine months, 16 lb. 4 oz. at ten months, 20 lb. 6 oz. at twelve months. Height, 31 in. at eighteen months, 32 in. at two years. Weight, 27 lb. 8 oz. at two years. Dentition delayed—2 teeth at eleven months, 14 teeth at two years. Benger's food employed at first, then Benger's food alternating with 'Ambrosia', later fresh milk and an adequate diet including butter and dripping. No signs of rickets developed. Normal height and weight at three years of age.

G. B. No. 314. Baby girl. Weights: 8 lb. 2 oz. at three months, 13 lb. at five months, 14 lb. at nine months, 15 lb. at ten months, 17 lb. 8 oz. at eleven months, 19 lb. at twelve months, 23 lb. 4 oz. at nineteen months. Height: $29\frac{3}{4}$ in. at fifteen months, $31\frac{1}{2}$ in. at $2\frac{1}{12}$ years. Dentition delayed—3 teeth at eleven months, 10 teeth at sixteen months, 14 teeth at twenty-one months. Breast-feeding was given alone to the age of seven weeks. Then secretion began to fail, and for a fortnight extra feeds of Nestlé's sweet milk were given. From nine weeks of age breast-feeding with 'Glaxo', and later with fresh milk. Weaned at eleven weeks and fed with a fresh milk-sugar-water mixture. From three months undiluted citrated milk employed. Improvement to five months of age. Then troublesome vomiting followed by febrile symptoms and intolerance. Subsequently fed with peptonized milk, then Benger's food, then Benger's food and 'Glaxo' No. 1, then Benger's food and 'Glaxo' No. 2, then Benger's food and 'Glaxo' full strength, then fresh milk citrated and an adequate diet with fresh milk later. No sign of rickets developed. Somewhat subnormal height and weight for age.

Method 4 e. Ten cases in this group are interesting owing to the fact that secretion of breast-milk failed or the amount of breast-milk proved inadequate for the child, who subsequently showed intolerance for either fresh milk or 'Glaxo' when fed by hand using normal standards of fat percentage. They were therefore fed for various periods with varying strengths and quantities of Nestlé's sweet milk until tolerance for fresh milk-fat became established, when substitution of fresh milk and other forms of fat in a general diet was gradually made.

None of these cases developed signs of rickets. They received constant supervision either as in-patients or out-patients at the Evelina Hospital, in order that the fat-carbohydrate balance of the diet should be corrected at the earliest possible date. Examples:

S. G. No. 487. Baby boy. Breast-feeding employed to the age of three weeks, fed by 'Glaxo' to the age of six weeks. Not thriving. From six weeks to ten months of age fed successfully with Nestlé's sweet milk and barley water. From ten months of age fed with fresh milk ℥xx to ℥xxx daily and an adequate diet including butter, dripping, and bacon fat. Dentition was delayed somewhat. 12 teeth at eighteen months of age. Normal height and weight at twenty-two months of age.

G. P. No. 468. Baby boy. Breast-feeding employed to the age of two months, when the child was weaned as he was not thriving. Suffering from a primary dyspepsia. Hand-feeding with 'Glaxo' attempted until the age of ten weeks. Failure. From ten weeks to eight months of age fed with Nestlé's sweet milk successfully; fresh milk introduced gradually and used entirely after the age of eight months with a diet containing adequate fat. Weight: 16 lb. 4 oz. at nine months of age. Satisfactory progress subsequently. No signs of rickets.

E. T. No. 494. Baby girl. Breast-feeding employed alone for ten days and then secretion began to fail. From ten days to five weeks of age breast-feeding was continued by night and bottle-feeding with Nestlé's sweet milk by day. From five weeks to five months of age bottle-feeding with Nestlé's sweet milk was continued as an attempt to feed the child with fresh milk failed at the age of six weeks owing to vomiting. Weight at five months, 9 lb. 9 oz. From five months to twelve months the baby was fed with undiluted citrated fresh milk —unsweetened—with a steadily rising weight. At twelve months of age the weight was 19 lb. 4 oz. The child took very little solid food until the age of twelve months. Subsequently satisfactory progress with a general diet including butter, dripping, and ℥xx fresh milk daily.

L. W. and T. W. No. 265 A, 265 B. Twins, boy and girl. Breast-feeding alone was employed until the age of four months, but as they were not thriving alternate feeds of Nestlé's sweet milk were started and continued until the age of ten months, when dripping and other food from the house table was allowed. Both babies were weaned at the age of fourteen months, and after that age received a general diet including dripping, occasionally bacon fat, margarine, and Nestlé's sweet milk—rarely ℥x to ℥xx fresh milk daily. Dentition—of both children—was somewhat delayed: 6 teeth at fifteen months of age. T. W. fontanelle open. L. W. fontanelle closed at fifteen months. Both children measured the same length, 28 in. at one year, but L. W. was two pounds heavier, and had always been the heavier child. T. W. died of broncho-pneumonia at the age of sixteen months. L. W. continued to make satisfactory progress with a general diet including dripping and Nestlé s sweet milk, no fresh milk included in the diet except in an occasional milk pudding. Height, 32 in. Stem height, 20 in. Weight, 27 lb. 19 teeth at two years of age. Satisfactory progress subsequently. Neither child developed signs of rickets.

B. W. No. 367. Baby boy. Breast-feeding alone was employed until the age of three months, when additional feeds, two daily, of Nestlé's sweet milk were given. The mother was engaged in married women's labour and the child was weaned at four months of age. After that date he was fed entirely by bottle with a mixture of 'Cow and Gate', Nestlé's sweet milk, and Marylebone cream to the age of twelve months. Thereafter he had a satisfactory diet including fresh milk ℥xx to ℥xxv daily. Weight, 24 lb. at eighteen months. Height, 31½ in. Dentition not delayed. 2 teeth at six months, 8 teeth at twelve months, 16 teeth at nineteen months. Subsequent progress satisfactory. No signs of rickets.

Method 5 a. In this group breast-feeding was practised to the age of twelve months, but for various reasons additional feeds of Nestlé's sweet milk—varying quantities—were given. Eight cases.

G. T. No. 189. Baby boy. He is one of a family of six children who have never suffered from rickets, and who have all been fed in the same way. Breast-feeding alone is given for three months, and then the mother has found that the children are not satisfied, so bottle-feeds of Nestlé's sweet milk are given, according to scale, alternating with breast-feeds until the age of twelve months. From the age of twelve months a general dietary with Nestlé's sweet milk is provided. 'The mother said that she believes in fat for children, and even when they are babies often holds meat fat in their mouths for them to suck' (voluntary statement). Margarine or butter with suet and bacon fat are constant items of diet during the second year. Dripping is frequently on the table.

G. T. made satisfactory progress up to the age of two and a half years, when he was a fine, well-grown child. Height: 34 in. at $2\frac{3}{12}$ years. Dentition: 4 teeth at fourteen months, 14 teeth at twenty months, 20 teeth at $2\frac{3}{12}$ years. He never showed any signs of rickets.

Method 5 b. In this group breast-feeding was practised for about the usual period, and when the child was weaned sweetened condensed milk was used, but the balance of the diet in the matter of fat deficiency was corrected by the use of additional fat in the form of dripping, butter, bacon, cod liver oil, suet, and eggs. Such cases should be compared with those occurring under the heading 'Rickets, fat deficiency with carbohydrate excess' (q. v.) where condensed sweetened milk being the milk food in use no additional fat is added to the diet.

The undermentioned examples under this heading—5 b may be quoted:

F. W. No. 438. Baby boy. A small baby at birth weighing 5 lb. He was breast-fed to the age of nine months. The mother's health was good, she was never short of food, she did not take extra milk herself during lactation, but occasionally, perhaps once a week, she took stout. The boy was weaned at nine months of age and subsequently fed on Nestlé's sweet milk and the house diet, which included milk pudding made with fresh milk, at least three times weekly. At twelve months his weight was 16 lb. 5 oz. Height, 27 in. Stem height, 17½ in. Not thriving, liable to diarrhoea (September 1920). Dentition, 8 teeth. No excess gas formation in the intestines. From the age of twelve months dripping and meat-gravy together with fresh milk pudding became regular items of diet. Sweetened condensed milk was continued. A small amount of cod liver oil was given with malt, ʒij t.d.s. (=ʒ ij cod liver oil daily). Rickets did not develop. There were no X-ray signs of rickets at either nine months or twelve months of age. At 1 $\frac{10}{12}$ years: Height, 30 in. Stem height, 18 in. Weight, 25 lb. Twenty teeth present. He was an active, somewhat thin, child. The same diet with sweetened condensed milk was continued. No fresh milk was used.

M. T. No. 187. Baby girl. Breast-feeding alone was employed until the age of four months, when the child weighed 7 lb. 1 oz. and had lost 1 lb. during the preceding six weeks. From four months to six months breast-feeding was continued with a small amount of malt and cod liver oil. ʒvj daily (= ʒij cod liver oil daily). There was plenty of breast-milk but the child did not thrive. At six months she was weaned and fed upon Nestlé's sweet milk with cod liver oil (ʒiv daily) and at once made marked improvement. From the age of nine months until fifteen months she received mutton broth, an egg daily, bread and margarine besides the Nestlé's sweet milk and cod liver oil. Improvement continued. Dentition: 2 teeth at eleven months, 6 teeth at twelve months, 8 teeth at fifteen months, and 16 teeth at twenty-two months. The fontanelle was hardening from the age of eleven months, and closed at nineteen months. Walking alone at fifteen months. From eleven months of age additional fats were introduced, including dripping, bacon fat, and margarine 4 oz. weekly. Nestlé's sweet condensed milk continued. Heights: 27½ in. at eleven months, 31½ in. at twenty-two months, and stem height 19½ in. Signs of rickets did not develop.

Method 6. This group—eight cases—includes the clinical reports of children who failed to digest milk fat during the early months of the first year, and who also in some cases showed some intolerance for carbohydrate until the age of about eighteen months. On this account they were regular hospital out-patients, either at the Evelina or Guy's Hospital, and malt or malted foods were employed for varying periods with diluted milk. The balance of the diet, fat-carbohydrate ratio, being restored at the earliest possible date. None of these children developed signs of rickets, though they were subnormal in height and weight for age with a delayed closure of the fontanelle. Thus:

Method 6 d. M. D. No. 240. Baby boy. Method of feeding, *vide supra*, 6 d. Dentition: 4 teeth at fifteen months, 11 teeth at twenty months, 13 teeth at twenty-one months, 14 teeth at 24 months. Fontanelle closure at twenty-one months. Heights: 28 in. Stem, 17½ in. at fifteen months, 30 in. at twenty months. Weights: 9 lb. 5 oz. at six months, 10 lb. 11 oz. at nine months, 12 lb. 6 oz. at eleven months, 16 lb. at fifteen months, and 22 lb. 12 oz. at twenty-two months. Signs of rickets did not develop.

Method 7. Nine cases. These cases are somewhat similar to those described under Method 5 (q. v.), but in the latter instance breast-feeding was employed for the normal period.

Method 7 a. In two cases the children progressed in normal manner with Nestlé's sweet milk without additions until nearly twelve months of age, when additional fat was given in the diet.

In one case from four months of age both Virol ʒj t.d.s. and olive oil ʒj were added to the bottle of Nestlé's sweet milk.

In another case margarine or dripping was added to the bottle, a small lump being shaken up with the warm condensed milk.

All the six children in this group were small, height and weight for age. Thus:

A. H. No. 415. Baby boy. Weight, 15 lb. 8 oz. at eleven months.

G. C. No. 374. Baby girl. Weight, 20 lb. 6 oz. at eighteen months, 22 lb. 6 oz. at twenty-two months.

Method 7 c. C. H. No. 235. Baby boy. This boy was also small and poorly developed. Signs of rickets did not appear. Weight: at nineteen months, 19 lb. 12 oz.; at twenty-one months, 21 lb. 4 oz.; at twenty-four months, 22 lb. 6 oz. Height: at twenty-one months, 29½ in.; at 2½ years, 32 in.; Stem height, 20 in. Dentition: first tooth at eleven months, 12 teeth at nineteen months, 16 teeth at twenty-four months, 20 teeth at 2½ years.

B. Non-rachitic Cases born in Rachitic Families.

186 Cases.

TYPES OF RACHITIC FAMILY.[1]

Methods of feeding (11).	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Totals.*
a. Breast-feeding for short periods, then fresh milk .	40	11	5	12	2	3	1	1	1	1	77
b. Breast-feeding for nine to twelve months, practically no other food	24	4	1	8	4	...	5	1	...	...	47
c. Breast-feeding for short periods, then 'Glaxo' or 'Ambrosia'	13	1	3	2	2	...	2	1	...	...	24
d. Breast-feeding for short periods, then Nestlé's sweet milk, then a general diet with dripping, bacon fat, &c., and Nestlé's sweet milk	14	1	2	...	...	1	...	...	...	...	18
e. Fresh milk only	2	1	...	...	...	...	3	1	...	...	7
f. 'Glaxo' only	3	...	...	...	1	...	...	...	...	...	4
g. Nestlé's sweet milk, then fresh milk	3	...	...	...	...	...	...	...	...	...	3
h. 'Glaxo', then fresh milk .	1	...	...	...	1	...	...	...	...	...	2
i. Diluted fresh milk, then Nestlé's sweet milk, then a 'war-time' diet with Nestle's sweet milk . .	1[2]	...	...	...	...	...	...	...	...	...	1[2]
j. Diluted fresh milk, then Allenbury No. 2 and 3 then 'Glaxo'	1	...	...	...	...	...	...	...	...	...	1
k. Allenbury Nos. 1, 2 and 3 with diluted fresh milk . . .	1	...	...	...	1	...	...	...	...	...	2
	103	18	11	22	11	4	11	4	1	1	186

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[1] Types of rachitic family.—1. Fat deficiency, Carboh. excess. 2. Poor breast-milk. 3. Prolonged breast-feeding. 4. Finance group. 5. Diathesis. 6. Carbohydrate excess. 7. Ante-natal defects. 8. Gastro-intestinal. 9. Post-infective. 10. Prematurity.

[2] V.H. No. 328 *vide infra.*

These are the records of the babies who have been born since the investigation started. They are the younger members of rachitic families who were already under observation.

Almost without exception all these children were under supervision of a Welfare Centre or 'Health Society' or hospital out-patient clinic. In the great majority of cases the mother was influenced by the advice of an Infant Welfare Centre in choosing a method of feeding her baby, and subsequently again used the Welfare Centre for consultation if a change in the method of feeding was made. In a large number of cases constant visits were paid to Welfare Centres throughout the first eighteen months of life although the baby remained quite healthy, the mother being stimulated to such attendance by the knowledge that an older child or children had suffered from rickets already, and by the fear that the baby would show signs of similar deformities.

If evidence were required of the immensely important and successful work which the Infant Welfare Centres are doing in London it is to be found in this record of preventive work among the younger members of rachitic families.

Eleven methods, only, of feeding are enumerated, as against thirty-five different methods detailed above which refer to the healthy children supervised as controls who came under observation mostly between the ages of six months and twelve months. The Welfare Centres, wisely, have refrained from adopting diversity of method, they have concentrated their attention upon the use of breast-milk, fresh cow's milk, and dried milk of two well-known brands. In those cases where sweetened condensed milk was employed as in method '*d*', owing to a temporary intolerance for milk-fat, the balance of the diet was rectified at the earliest possible moment before the age of twelve months by the additions advised for and made to the dietary in the form of dripping, butter, bacon fat, and suet.

One case requires special mention.

Method 1. V. H. No. 328. This child was one of twins born during the war. No breast-feeding was possible, the mother aged 42 had no breast-milk, and both children were fed during the first year of life upon fresh cow's milk and barley water. During the second year the twins were given sweetened condensed milk and a war-time dietary; fresh milk could only be obtained with difficulty and was therefore given up, the family were very short of butter, margarine, dripping, and suet until the children were four years old. The other twin E. R. H. developed rickets with severe deformities, this child V. H. remained small and of subnormal weight though rickets did not develop. To all appearances both children had the same diet but V. H. had a better appetite, and often finished her sister's dinner, the latter being 'very particular about her food' and very difficult to feed even with that small amount of fat which was the family ration. For this reason E. R. H. was given more sugar.

Both children improved as a result of adding fresh milk and cod liver oil to their diets. At 6 3/12 years of age E. R. H. was 41½ in. and 24½ in. stem, and V. H. was 43½ in. and 24½ in. stem.

The cases have been arranged in tabular form according to the type of rachitic family in which the birth took place.

C. Control Cases which Developed Rickets

8 Cases.

When the work was started it was expected that a considerable number of control cases would develop signs of rickets before the investigation was concluded, owing to the irregular industrial conditions which prevail in the area of London under survey where are the homes of the great majority of the families.

Only eight control cases developed rickets.

Three reasons have been responsible for this low incidence.

1. First, rickets is more likely to occur and is more severe if it occurs among children who have had a bad start in life during the first six months, with a bad ante-natal history owing to poor health and ill-feeding of the mother during her pregnancy, and who are then fed between the ages of six months and eighteen months with an ill-balanced diet. A large number of the control cases selected between the ages of six months and twelve months were sturdy children of normal weight and size, who had been fed according to generally accepted principles by one of three methods (*a*) Breast-feeding, (*b*) Bottle-feeding—fresh cow's milk, (*c*) Bottle-feeding—dried cow's milk. The start in life had been good.

2. Secondly, the Medical Research Council placed funds at my disposal in order to provide a continuation of satisfactory diet should industrial conditions lead to deterioration in the quality of the food of the family owing to money shortage. On several occasions where unemployment for the wage-earner had supervened this provision was made, and for a fortnight or three weeks until the conditions improved or the family were placed in contact with the local Infant Welfare Centre or Health Society, adequate supply of fresh milk, dried milk and dripping was ensured for the baby under observation. With some families this help was given on more than one occasion, 1½ pints of fresh milk daily, or 1½ pounds of Glaxo weekly, or half a pound of dripping weekly being the items employed.

This preventive work was further assisted by Government legislation in the autumn of 1919 which gave financial assistance to Local Authorities who provided milk to necessitous mothers and infants.

3. Thirdly, the activity of the Infant Welfare Centres, which have increased in number during the last three years, has been largely responsible for the prevention of rickets in younger members of rachitic families, as in the case of the series—186 in number—quoted above.

The following short notes have reference to the eight control cases which developed rickets:

1. R. H. No. 414. Baby girl—a small child at birth but apparently healthy. Breast-feeding alone was employed to the age of 3½ months. From the age of 3½ months alternate feeds of breast-milk and diluted fresh milk with Ridge's food were given, from the age of six months fresh milk with Ridge's food. Total fresh milk ℥x to ℥xv daily. At the age of eleven months the diet was further increased by potato, gravy, bread, and margarine. Signs of rickets were definite at the age of ten months, at the age of eleven months

the lower radial epiphyses were enlarged and deformity of the tibiae was present, increasing in degree. Height 26 in. at 11 months. 8 teeth. Fontanelle width 2 fingers breadth ($1\frac{1}{4}$ in.) not hardening.

2. H. H. No. 254. Baby boy. Breast-feeding was employed until the age of fourteen months, very little other food was given to the child up to that age. The mother herself was experiencing war-time food shortages during both pregnancy and lactation, she was also ill, suffering from a varicose ulcer. After the boy was weaned he received no fresh milk, his diet included 'plenty of potato', occasionally dripping which at that date (October 1919) was just coming into the retail market, sweetened condensed milk, margarine, gravy, and bread. Early signs of rickets appeared at the age of seventeen months, and deformities with enlarged epiphyses were found at nineteen months. He made a rapid improvement with the addition of $1\frac{1}{2}$ pints of fresh milk to the diet in place of sweetened condensed milk, potato was limited, and dripping given at least once a week. No cod liver oil was employed.

3. A. M. No. 51. Baby girl. Breast-feeding was employed until the age of fifteen months; very little other food was given until the age of one year when a little potato and gravy, bread and margarine, and about ℥x fresh milk daily were added to the diet. At the age of fourteen months, when the child had six teeth, the epiphyses were enlarged and both tibiae were bowed.

Another child, breast-fed to the age of eighteen months, developed signs of rickets at sixteen months.

Neither of the parents suffered from rickets as children. A paternal aunt had rickets very badly as a child, and was severely bandy-legged when she died at the age of 40.

4. R. P. No. 224. Baby boy. Breast-feeding was employed until the age of fifteen months when early signs of rickets were present. Apart from breast-milk very little other milk was given him, the diet of the house—irregular and poor in quality—was started from the age of twelve months. After the age of sixteen months he made rapid improvement with a diet containing fresh milk and dripping as a regular feature. Height, 29 in. Stem, $18\frac{3}{4}$ in. 7 teeth at fifteen months. Height, $30\frac{8}{4}$ in. Stem, $18\frac{3}{4}$ in. 11 teeth at twenty-two months.

An elder brother, breast-fed to the age of eighteen months developed rachitic deformities before breast-feeding was discontinued, a war-time dietary having been started at the age of twelve months. The mother herself suffered from war-time food shortages during both pregnancy and lactation.

The mother as a child was bandy-legged, and also her twin brother and father, whose deformed legs remained obvious until he died.

5. M. S. No. 353. Baby girl. Breast-feeding was employed in all until the age of three months, from the age of one month, when the mother went to work, the child received Nestlé's sweet milk alternating with breast-feeds. The mother was in very poor health during her pregnancy with this child—suffering throughout from hyperemesis,. Breech delivery after a transverse presentation. There was plenty of breast-milk when the child was born. From three months to twelve months of age the baby was fed on 'Glaxo' receiving practically nothing else and remaining under supervision of a Welfare Centre.

After the age of twelve months a general dietary was allowed, and Nestlé's sweet milk was substituted for 'Glaxo', though the latter was given occasionally. Dripping was used rarely. Rickets was first suspected at the age of twenty months when the fontanelle had closed. Weight, 23 lb. Height, $30\frac{1}{2}$ in. Teeth, 12.

Enlargement of epiphyses and early deformities developed between the ages of twenty and twenty-five months.

No history of rickets in either father's or mother's families.

This baby made undoubtedly good progress with 'Glaxo' and relapsed subsequently.

6. T. T. No. 437. Baby boy. No breast-feeding was possible. 'Glaxo' was given by bottle successfully until the age of two months, when it was given up as 'too expensive'. The baby was then fed on fresh milk and barley-water, receiving one pint of milk daily at four months, and $1\frac{1}{2}$ pints daily at six months of age, making satisfactory progress to the age of eight months. The father then became unemployed and the child was given Nestlé's sweet

condensed milk; at the age of nine months potato with gravy, bread and margarine were started, Nestlé's sweet milk continued—the mother buying three tins weekly. At the age of twelve months early signs of rickets had appeared. Rachitic rosary, enlarged epiphyses, and early deformity of the tibiae. 6 teeth at twelve months, fontanelle nearly closed.

At twenty-one months of age he had 12 teeth, the fontanelle had recently closed, a depression remaining. Height, 27 in. Stem height, 16½ in. Unable to walk alone. Bony changes were less marked. His slow progress towards recovery was due to the money shortage of the family. He improved more rapidly as a result of hospital dietary with fresh milk, having been transferred to hospital for broncho-pneumonia.

7. G. W. No. 440. Baby boy. Breast-feeding alone employed to the age of six months, the baby making satisfactory progress. At six months the child was weaned and bottle-fed with Nestlé's sweet milk, two of the feeds daily being made up with boiled bread-crumb. At nine months potato was added to the diet, and from ten months of age the ordinary house diet, including bread and margarine, a little meat food, very rarely an egg, gravy and potato with Nestlé's sweet milk. At fourteen months of age he had 7 teeth, the fontanelle was 1¾ in. wide, showing no signs of closing. Weight, 18 lb. 6 oz. Height, 27 in. At that age he was a weakly child who could only just stand, and who was making slow progress. At the age of fifteen months he was in hospital for measles followed by broncho-pneumonia, returned home after three weeks, and for two months the mother gave him fresh milk ℥xv to ℥xx daily with the house diet which was of variable quality. At eighteen months he was making slow progress. Owing to money troubles the amount of fresh milk was then reduced to ℥x daily maximum. Not always obtained.

At twenty months. Height, 30 in. Stem, 19½ in. Fontanelle, 1¼ in. wide. 16 teeth present.

At twenty-two months marked signs of rickets developed with deformities.

There were two older children suffering from rickets in this family, the deformities developing while they were taking a war-time dietary with sweetened condensed milk.

8. V. W. No. 87. Baby girl. Breast-feeding alone was never possible, only one breast was employed owing to a mammary abscess which was opened when the mother was 8½ months pregnant. From birth alternate feeds of breast-milk and bottle, fresh milk and water, equal parts, bulk ℥iij with one teaspoonful of lime-water were used. The mother was taking 'lactagol' but in her opinion that preparation did not increase secretion of breast-milk. Subsequently the bottle-feeds also contained Marylebone cream, sugar, and sodium citrate, the lime-water being omitted. At six months of age the child was weaned, and bottle-feeding with fresh milk, water and sugar was continued. At eight months of age extras were started, bread and milk, barley and milk.

When nine months old the father became unemployed.

From that date (Christmas 1920), Nestlé's sweet milk replaced fresh milk, and the diet included gravy and bread, bread and margarine, bread and condensed sweet milk.

Between the ages of nine months and thirteen months, marked signs of rickets with deformities developed. Marked excess of gas formation in the small intestine. At thirteen months there were no teeth, the fontanelle was 1¾ in. wide, not hardening at all. Weight, 14 lb. The child had previously been 10 lb. 4 oz. at three months of age, 13 lb. 2 oz. at six months of age. Height, 25½ in. at six months.

Immediate improvement occurred when under supervision of a Welfare Centre, fresh milk ℥xxx daily was substituted for the sweetened condensed milk. There were 5 teeth at seventeen months with a weight of 18 lb. 10 oz.

IV. RICKETS.

533 Cases.

In this section details are given of all the cases of rickets which came to hospital or which were found with the help of various health centres.

It was thought better to include in the series all the cases investigated, whether premature or full-term deliveries, and to include also those which prior to the onset of rickets had suffered from infective disease and others which had been of small weight at birth owing to the illness or ill-health of the mother during her pregnancy.

The tables therefore give a continuous record of the work and indicate the percentage of cases in which dietetic or other factors are of importance:

The cases are arranged in the following groups:

1. Dietetic factors.
    - A. Fat deficiency with carbohydrate excess.
    - B. Breast-feeding.
    - C. Finance. Unsuitable diet owing to money shortage in the home.
    - D. Carbohydrate excess.
2. Factors other than diet.
    - E. Diathesis.
    - F. Ante-natal influences.
    - G. Gastro-intestinal disorders.
    - H. Post-infective malnutrition.
    - I. Prematurity.
3. Unknown causation. Unexplained circumstances. (*Vide* Appendix 7.)

Two tables have been drawn up.

Table No. 10 shows the cases arranged according to the date of incidence. This table shows that changing conditions in the industrial world produce a variation in causative factors. The early cases—250 in number—occurred in families who were still suffering from conditions attributable directly to the war, many of the children were born during the war, and of the remainder the pregnancies had been passed under war conditions. Among this early series—March 1919 to April 1920—the group headed 'Finance' occupies third place. The later cases, 55 in number, came under observation for the onset of rickets during the terminal part of the work in the seven months April to October 1921, at a time when many homes were experiencing the effects resulting from the general unemployment which dated from October 1920 and which was further intensified by the four months of coal strike—April to July 1921. On this account the group described 'Finance' has assumed the first place, the food of this group being a variable diet, inadequate, border line or satisfactory, changing in quality from day to day but mostly unsuitable for infants, is directly dependent upon the prevalence of unemployment, casual and part-time labour rather than on full-time work. Such a diet includes in its composition the cheaper carbohydrate foodstuffs rather than the expensive fats. This variation in causative factors during three years owing to economic disturbances is an indication that under unusual social conditions or in a restricted area of work erroneous conclusions might be drawn as to the incidence of rickets.

Table No. XI classifies the clinical stages of rickets, and is of importance in showing that certain causes predispose to severe types of rickets with deformities, and that other less common conditions—e.g. No. 5 Carbohydrate excess and No. 6 Ante-natal defects are productive more especially of early signs of rickets without deformities.

In viewing the subject of rickets from a national standpoint it is important to remember the circumstances under which the largest number of cases and the most serious types of rickets occur. Table No. XI makes these points obvious.

The various groups of rickets cases will now be described in detail seriatim.

TABLE X. *Rickets.*

533 Cases.

CASES 1 to 533.
MARCH 1919 to October 1921.

		Cases.	*Per cent.*
1.	Fat Deficiency with Carbohyd. Excess	231	43·3
2.	Breast-feeding	88	16·5
3.	Finance	86	16·1
4.	Diathesis	39	7·3
5.	Carbohyd. Excess	24	4·5
6.	Ante-natal	22	4·1
7.	Gastro-intestinal	17	3·1
8.	Post-infective	14	2·6
9.	Prematurity	3	0·5
10.	Unexplained	9	1·7

CASES 1 to 250.
March 1919 to April 1920.

		Cases.	*Per cent.*
1.	Fat Deficiency with Carbohyd. Excess	112	44·8
2.	Breast-feeding	41	16·4
3.	Finance	33	13·2
4.	Diathesis	17	6·8
5.	Carbohyd. Excess	15	6
6.	Gastro-intestinal	10	4
7.	Post-infective	10	4
8.	Ante-natal	6	2·4
9.	Prematurity	2	0·8
10.	Unexplained	4	1·6

Recent Figures. 55 Cases.

April 1921 to October 1921.

		Cases.	*Per cent.*
1.	Finance	19	34·5
2.	Fat Deficiency with Carbohyd. Excess	14	25·4
3.	Breast-feeding	7	12·7
4.	Diathesis	4	7·2
5.	Ante-natal	4	7·2
6.	Carbohyd. Excess	3	5·4
7.	Post-infective	2	
8.	Gastro-intestinal	1	
9.	Prematurity	1	
10.	Unexplained	Nil	

TABLE XI. *Rickets.*

533 Cases.

Arranged under headings indicative of causative factors and classified according to severity of clinical features.

Group.	*Severe Deformity.*	*Slight Deformity.*	*Prerachitic early signs.*	*Totals.*	*Percentage.*
1. Fat Deficiency with Carbohydrate excess . . .	25	189	17	231	43.3
2. Breast-feeding—					
(a) Poor Breast-milk . .	Nil	30	7	37 } 88	16·5
(b) Prolonged Breast-feeding	2	43	6	51	
3. Finance	15	61	10	86	16·1
4. Diathesis	7	27	5	39	7.3
5. Carbohydrate Excess . .	1	9	14	24	4·5
6. Ante-natal	Nil	11	11	22	4·1
7. Gastro-intestinal . .	Nil	14	3	17	3·1
8. Post-infective	1	11	2	14	2·6
9. Prematurity	Nil	3	Nil	3	0·5
10. Unexplained	...	...	...	9	1·7
	51	398	75	533	

(1) Dietetic factors

A. FAT DEFICIENCY WITH CARBOHYDRATE EXCESS.

231 Cases. 43·3 per cent.

(*a*) Severe deformities	25
(*b*) Slight deformities	189
(*c*) Prerachitic early signs . . .	17

The methods of feeding the cases of rickets collected in this group are again arranged under twelve headings on broad lines without any detailed particulars.

Summarized thus the classification appears as follows:

	Cases.	*Per cent.*
1. Breast-feeding	Nil	8·6
2. Breast-feeding, then fresh milk . . .	2	
3. Breast-feeding, then dried milk . . .	Nil	
4. Fresh milk	7	
5. Dried milk	Nil	
6. Fresh and dried milk	Nil	
7. Fresh milk and patent foods . . .	11	
8. Condensed sweet milk	55	91·3
9. Breast-feeding, then condensed sweet milk	74	
10. Breast-milk with foods	Nil	
11. Mixed methods	13	
12. War shortages, &c.	69	
Total cases	231	

Examined in greater detail the cases were fed in 28 different ways. Thus:

	Methods of feeding (28).	*(a) Severe.*	*(b) Slight.*	*(c) Prerachitic.*	*Remarks.*
1.	Breast-feeding for short periods, then sweet condensed milk	5	55	5	In twelve cases the mother was engaged in married women's labour.
2.	Breast-milk to about nine months of age, then a 'war-time dietary' with fresh milk ½ pint maximum or sweet condensed milk	4	37	2	In one case the mother was engaged in married women's labour.
3.	Nestlé's sweet condensed milk .	2	24	nil	
4.	Nestlé's sweet milk and barley water	1	9	nil	
5.	Breast-milk poor for short periods, then Nestlé's sweet milk	nil	5	4	
6.	Fresh milk diluted, then a 'war-time' diet with fat deficiency	1	10	1	In one case the mother was engaged in married women's labour.
7.	Nestlé's sweet milk and Ridge's food	3	5	nil	
8.	Nestlé's sweet milk and Neave's food	nil	5	nil	
9.	Nestlé's sweet milk and bread sop	3	1	nil	
10.	Fresh milk, then Nestlé's sweet milk and bread sop, then a 'war-time' diet, potato, bread, and rice	1	6	nil	
11.	Fresh milk diluted with sugar excess, then 'ordinary food' with ½ pint fresh milk max. and little fat in the diet	3	3	1	
12.	Fresh milk diluted, sugar, oatmeal, and bread sop	1	4	1	
13.	'Glaxo,' then Nestlé's sweet milk and 'ordinary food' including margarine	1	3	1	
14.	Breast-feeding to four months, then 'Glaxo' to 11 months of age, then a 'war-time' (1917) diet with skim-condensed milk	nil	6	1	
15.	Breast-feeding to ten weeks, then adequate fresh milk to twelve months, then ordinary diet with very little fat and ℥xv to ℥xx fresh milk (Max.)	nil	1[1]	nil	[1] M.C. No. 452. Prematurity eight months. Weight 6 lb. Cross index.
16.	Breast-feeding to six weeks, then adequate fresh milk and barley water, then skim condensed (goat) milk, bread sop and sugar, later ordinary food, sugar excess, fat deficiency	nil	1	nil	
17.	Breast-feeding to one month, then Nestlé's sweet milk to five months, then Savory and Moore food, with additional sugar and fresh milk	nil	1[1]	nil	[1] D. P. No. 469. Rickets with scurvy at nine months. 'Diathesis' mother. Cross index.

(continued):

	Methods of feeding (28).	*(a) Severe.*	*(b) Slight.*	*(c) Prerachitic.*	*Remarks.*
18.	Breast-feeding to ten months, mother in poor health, then ordinary food, potato and bread excess with fresh milk, ℥ x̄ maximum	nil	nil	1	
19.	Nestlé's sweet milk and Milo food	nil	1	nil	
20.	Nestlé's sweet milk with barley gruel and later Robb's biscuit to 14 months	nil	1	nil	
21.	Fresh milk, then Nestlé's sweet milk and 'Empress' food with extra sugar from ten to twenty-two months	nil	1	nil	
22.	'Glaxo' to twelve months of age, then ordinary house food without any milk at all	nil	1[1]	nil	[1] B. D. No. 455. Early deformities at eighteen to twenty-one months of age.
23.	'Glaxo' to twelve months of age, adequate, then skim condensed milk with carbohydrate excess, potato, spaghetti, macaroni, rice	nil	2[2]	nil	[2] S. C. No. 450, one case from an Italian family of northern Italy who did not use olive oil in the house diet.
24.	'Glaxo' to eight weeks, then Allenbury No. 2 food to nine months of age	nil	‡[3]	nil	[3] G. K. No. 464. Prematurity. Induction at eight months. Did not thrive from birth. Mother, pneumonia, no breast-milk. Rickets with scurvy at nine months. Mother, rachitic pelvis hence induction of labour, severe rickets as a child. Cross index diathesis.
25.	Allenbury No. 2 food, then Nestlé's sweet milk	nil	1	nil	
26.	Allenbury No. 1 and No. 2 foods, then Allenbury No. 3 food with Nestlé's sweet milk	nil	2	nil	
27.	Fresh milk (diluted), then Allenbury No. 2 and No. 3 foods	nil	1	nil	
28.	Fresh milk (diluted), then Savory and Moore's food (additional)	nil	2	nil	

Note.—In fourteen cases the mother was engaged in married women's labour.

This group, Fat deficiency with carbohydrate excess, includes by far the largest number of the total rickets cases investigated. If the early prerachitic cases are excluded the total numbers 47·6 per cent. of those who develop deformities.

At the outset an attempt was made to consider the cases in this group under two headings:

1. Fat deficiency with relative carbohydrate excess.
2. Fat deficiency with actual carbohydrate excess.

An accurate subdivision on these lines as the work continued was found to be impossible owing to the fact that money is chiefly responsible for relative or actual carbohydrate excess in the great majority of homes, and the money factor being a variable one as a result of the presence of so much casual labour the conditions altered from week to week. Actual carbohydrate excess appeared when there was rather more money, thus fat deficiency remained the constant and relative or actual carbohydrate excess was the variation.

Methods of feeding are described under 28 different headings. Of these, 15 headings deal with methods of feeding by bottle, and the baby was still being fed by bottle when signs of rickets appeared. These entirely bottle-fed cases of rickets include 14 with severe deformities, 114 with slight deformities, and 9 with early signs of rickets. Total 137. Subheadings Nos. 1, 3, 4, 5, 7, 8, 9, 17, 19, 21, 24, 25, 26, 27, and 28.

Under 13 headings are detailed the diets of those children who, being older, were receiving solid food when rickets was diagnosed; these include 11 cases with severe deformities, 75 with slight deformities, and 8 with early signs of rickets. Total 94. Subheadings Nos. 2, 6, 10, 11, 12, 13, 14, 15, 16, 18, 20, 22, 23.

Attention may be next directed to the type of milk food which was being employed for the child when signs of rickets appeared.

In 156 cases some form of sweetened condensed milk was the variety of milk employed; these include 16 with severe deformities, 129 with slight deformities, and 11 with early signs of rickets.

In 43 other cases sweetened condensed milk was sometimes used; these include 4 with severe deformities, 37 with slight deformities, and 2 with early signs of rickets.

Eighteen different varieties of sweetened condensed milk were found to be on sale in South London where most of the cases lived, and there are certainly others. These vary immensely in the character of milk which they yield when water is added, but considerations of price largely determine their sale in a district where casual labour is so common. As income diminishes owing to casual labour or unemployment fresh cow's milk gives place to sweetened full-cream condensed milk, and the latter in turn to a cheaper brand of skimmed condensed milk when a further fall in wages occurs.

In addition to the above-mentioned variation in percentage composition of different brands of condensed milk, individual samples from the same firm vary considerably in the fat content. Thus I learned from the general manager of the largest condensed milk firm in London that a June batch of condensed milk would always be sold to retailers before a February batch, because the former is more likely to deteriorate during storage owing to the higher percentage of fat which it contains, the milk having been obtained from grass-fed cows. This was stated to be the reason that the tins are not dated at the time of condensation, as such procedure would influence adversely the sale of the earlier dated batch. The manager in question was quite frank in admitting the variability of the fat content. He attributed such variation entirely to the change in feeding of the cows.

A commonly accepted analysis of this brand of sweetened condensed milk before the war was: Proteids, 11 per cent. Fat, 11 per cent. Sugar, 55 per cent. It is sold as a full-cream milk.

A recent analysis of the same brand (June, 1921) gives: Total solids, 76·00 per cent., including fat, 10·4 per cent. Proteids calculated from nitrogen, 8·93 per cent. Milk sugar, 13 per cent. Cane sugar, 40·30 per cent. Ash, 2·10 per cent. Acids calculated as lactic acid, 0·50 per cent. Free from boracic preservative.

During the year 1919–1920 the retail price of this milk rose from 1*s.* 2½*d.* per tin to 1*s.* 6*d.*, and subsequently after a short period the price fell to 1*s.* 4½*d.*, at which price it remained until the autumn of 1921. In the autumn of 1919 the retail price of fresh milk in London had risen from 8*d.* to 1*s.* per quart, and sugar was still rationed, so it is possible that the impression prevailing at that time among out-patient parents that the milk contained less sugar than before the war was correct. Recent analysis shows that its percentage composition is very similar to those obtained before the war, and saccharin could not be detected.

Another brand in common use in South London gives the following analysis (June, 1921): Total solids, 76·05 per cent., including fat, 9·80 per cent. Proteids calculated from nitrogen, 8·80 per cent. Milk sugar, 12·40 per cent. Cane sugar, 41·35 per cent. Ash, 2·10 per cent. Acids calculated as lactic acid, 0·61 per cent. Free from boracic preservative.

Among the poorest of the rachitic families in this group a cheaper brand of condensed skimmed milk is employed.

A common brand in use gives the following analysis (June, 1921): Total solids, 71·85 per cent., including: Fat, 0·40 per cent. Proteids calculated from nitrogen, 10·45 per cent. Milk sugar, 15·11 per cent. Cane sugar, 41·52 per cent. Ash, 2·75 per cent. Acids calculated as lactic acid, 0·78 per cent. Contains a trace of boracic preservative.

In addition to the fact that these condensed sweetened milks give a low percentage of fat and a high percentage of sugar, when diluted according to the directions of the condenser, it must be remembered that an enormous amount of variation is met with in actual dilution by the mother, especially if the family are in unfortunate circumstances, and an attempt is being made to make the tinned milk 'go as far as possible'. Thus, during the investigation dilutions employed were found to vary from 1 in 8 to 1 in 20, and the latter reading had been used for a rachitic child over a period of several months.

It is an interesting fact that if cane sugar is employed for preserving purposes in milk condensation it is not possible to add cream to the mixture before condensation with the idea of raising the fat percentage, for if such addition of fat be made the mixture tends to become 'cheesy' after it is canned, and the product is no longer marketable.

Fresh milk. Nos. 2, 6, 11, 12, 15, and 18.

In 70 cases fresh cow's milk was the type of milk food employed when signs of rickets first appeared, but of these in only 27 cases was fresh milk used regularly, for in 43 cases sweetened condensed milk was frequently given in lieu. (*Vide* Group 2.) These cases include 9 with severe deformities, 55 with slight deformities, and 6 with early signs of rickets.

From a study of the cases in this group it appears that if at the age of ten to twelve months only ten fluid ounces of fresh milk were used in the diet, and the only other fat was margarine, prerachitic early signs or rachitic deformities appeared subsequently, and the deformities increased more rapidly and became more severe as the amount of carbohydrate was increased at the expense of the fat. This change in the diet more oftenthan not was prompted by money shortage rather than by ignorance.

Besides the deterioration in the quality of the milk purchased when wages fall there is a disappearance of dripping, bacon fat, suet, lard, and butter, which are replaced by margarine, and the last named eventually gives place to treacle or jam with a further failure of housekeeping money. Sometimes if the money will allow of it, the mother does replace the fat by substitutions in the form of potato, bread, or oatmeal—relative to actual carbohydrate excess—such substitutions depending upon the money which she may earn if she is successful in obtaining married women's labour. (*Vide* Appendix 5.)

When the investigation was resumed in April 1919 it was impossible for the families in the riverside districts to buy either butter or dripping, and the margarine on sale at that time, and for about nine months afterwards, contained no animal fat (F. G. Hopkins). During the autumn of 1919 dripping again became possible as an item of dietary in a poor home (still more so in the spring of 1920) owing to improvement in the quality of meat on sale, and in March 1920 there were several qualities of margarine on sale from 1*s.* 2*d.* per pound upwards, the more expensive brands of which at about 2*s.* per pound were said to contain animal fat. Some of the families were in a position to buy the better quality of margarine at that date. In May 1921 butter was on sale at 1*s.* 8*d.* per pound, and it had reappeared in the diet of many families, while margarine could be obtained at 8*d.* per pound.

The mother was always questioned as to her own ideas on the feeding of small children, leading questions were avoided, and particular note taken of voluntary statements as to dietetic details, such information being subsequently confirmed or amended at the home visits made later by the visitors.

The worst cases of rickets with most marked deformity in this group were certainly found in homes where with a small amount of fat in the diet there was marked excess of cane sugar rather than of starch. Such cases are those of children who will always prefer sweetened condensed milk, who refuse fresh milk unless it is sweetened to excess, and who will not eat margarine or butter unless the slice of bread is also covered with a layer of sugar. That such excess of sugar is rapidly oxidised and broken up with production of heat seems undoubted, and free sweating is more marked when there is definite fat deficiency. The much distended abdomen with marked excess of gas formation is another constant feature. It does not appear that hyperglycaemia occurs. In 200 such cases collected before the war who showed marked deformities, and whose diet was distinguished by these features, glycosuria was never found. In some cases the urine was examined repeatedly.

One case in the series (M.C., No. 452, Subheading 15) requires a special note as the amount of fresh milk provided is on the borderline of requirement, and for some children would probably have been adequate.

The baby, however, was a premature eight months' child who was fed to the age of ten weeks with breast-milk, and then weaned as 'the breast-milk did not seem to satisfy her', and the mother did not think that secretion of milk was adequate. From the age of ten weeks the child was fed upon fresh milk, sugar, and water under direction of a Welfare Centre, with a steady rise of weight. Except a crust practically no other food apart from the milk was given until the age of twelve months, when the baby was taking ℥xxx of sweetened milk daily.

After the age of twelve months ℥xv to ℥xx fresh milk was given daily with a general dietary, which contained very little fat apart from margarine, but was otherwise varied, including fruit and an occasional egg. The child's appetite was poor, and from birth she had been somewhat difficult to feed. She walked at the age of eleven months, and to this fact the mother attributes the deformity of the tibiae. No large quantity of cane sugar was allowed, though the milk had always been sweetened.

Early rickets was diagnosed at sixteen months, and since that date the lower radial epiphyses have enlarged, the tibiae have become bowed, and the abdomen has become distended, excess gas formation being marked.

At the age of twenty-one months the deformity of the tibiae was rather more marked. There were 13 teeth. The weight was 23 lb. 12 oz., and the height 32 in.

The diet has not included milk puddings, suet, bacon, or meat-fat. Dripping has been given rarely. Gravy, potato, greens, cornflour, occasionally custard made from powder, bread, and margarine are the main items of diet. The fontanelle had closed at twenty-one months.

There is no history of rickets in either father or mother.

Another case, B.D., No. 455, Subheading No. 22, was a healthy baby girl who was fed successfully with 'Glaxo' under supervision of a Welfare Centre to the age of twelve months. There were no signs of rickets at that age, and the child was of normal standard.

After twelve months the baby refused all milk food, and no attempt was made to enforce it. The ordinary house diet containing margarine, occasionally a little butter or dripping, no other fat, and about three-quarters of a pound of sugar weekly.

Signs of rickets with deformities developed and became more marked between the ages of eighteen and twenty-one months.

Patent Foods. Six different varieties of carbohydrate infant foods appear in the series. Twenty-three cases were fed continuously by this method, and these included 3 cases of severe deformity and 20 cases of slight deformity.

Of these, in 18 cases the food was used as an addition to Nestlé's sweet condensed milk, and the resulting food was very deficient in fat with marked excess of sugar and starch.

The explanation that so small a percentage of cases were fed on patent foods is found in the fact that the great majority of families were of the poorer industrial class, who buy sweetened condensed milks instead of the more expensive foods such as the Allenbury preparations, but of 108 cases of rickets, collected between the years 1905 and 1914 in the suburban districts of London, in no less than 61 cases patent foods made up with water or milk—fresh or condensed in variable dilutions—formed the method of feeding for at least four months prior to the onset of rachitic deformity. In all of these suburban homes the surroundings were healthy and open, nor were there any money difficulties resulting from an increase of family out of proportion to rise in wage.

B. BREAST-FEEDING.

88 cases. 16·5 per cent.

(*a*) 'Poor breast-milk'	. .	37 cases
(1) Severe deformities	.	Nil
(2) Slight deformities	.	30
(3) Prerachitic early signs	.	7

Condition of Mother.	*Length of Lactation.*							
	6 months.	*7 months.*	*8 months.*	*9 months.*	*10 months.*	*11 months.*	*12 months.*	*Totals.*
Mother was ill. Anaemia. Nervous exhaustion. Infective disease.	1	...	1	2	2	...	2	8
Mother was in 'poor health'. Father unemployed.	1	...	...	...	1	1	7	10
Mother ill-nourished. War-time lactation diet.	2	...	1	2	3	1	7	16
Mother losing weight latterly. Cause unknown. Rickets attributed by mother to heavy weight of child.	...	...	...	...	...	...	1[1]	1
Mother pregnant	...	1[2]	...	...	1[3]	...	...	2

Note.—In *ten* of the above cases the mother was engaged in married women's labour.

[1] Prerachitic signs only. Complete recovery of child. Immediate improvement with hand-feeding.

[2] For five months of the seven months' lactation the mother was pregnant with her second child. She was also at work. Signs of rickets were present soon after birth. Prerachitic. Subsequent recovery with hand-feeding. E. C. Boy. No. 451.

[3] For four months of the ten months' lactation the mother was pregnant. Prerachitic. Subsequent recovery with hand-feeding. S. B. Boy. No. 476.

(*b*) Breast-feeding prolonged . . 51 cases

In every instance lactation was prolonged in order to save money.

(1) Severe deformities . .	2
(2) Slight deformities . .	43
(3) Prerachitic early signs .	6

Length of time fed at the breast.	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
For twenty-four months . .	1	6	...
For twenty-two months . .	...	1	...
For twenty months . . .	...	2	...
For nineteen months . .	...	1	...
For eighteen months . .	...	9	...
For seventeen months . .	...	4	...
For sixteen months . . .	1	4	2
For fifteen months . . .	...	9	3
For fourteen months . .	...	5	1
For thirteen months . .	...	2	...
Totals	2	43	6

Note.—In *three* of the above cases the mother was engaged in married women's labour, the children in question were breast-fed to the ages of twenty-four months (severe deformities), eighteen months, and seventeen months respectively.

Great care was taken in obtaining the details and the ante-natal history relating to this group. In all of them signs of rickets actually developed while the child was at the breast.

Two subdivisions have been made:

(*a*) 'Poor breast-milk', 37 cases.

(*b*) Prolonged breast-feeding, 51 cases.

(*a*) 'Poor breast-milk.' This term implies that the child did not thrive when taking breast-milk, and the mother was ill during lactation or she was receiving insufficient or unsuitable food with a falling body-weight, in many cases due to war-time shortages or to the unemployment or casual employment of the wage-earner during his wife's pregnancy and lactation.

In ten instances the nursing mother herself was at work. In the report of the Glasgow investigation 'Human milk was always taken as of average composition' and 'In the cases entirely breast-fed the amount of fat was thus always taken as sufficient'.

The following are the notes obtained in typical London homes, and the statements and details recorded are characteristic of this group:

E. A. No. 368. Father a waterside labourer. Casual employment, an average of 3½ days weekly. Giving 28*s.* weekly and also helps with clothing and food. The mother says that there was a marked difference in her nourishment during the two pregnancies. She was short of food during her first pregnancy, August 1917 to May 1918, and the food was of poor quality. 'The child did not thrive on the breast-milk.' The baby was weaned at the age of ten months. Signs of rickets were then present. The second child, also breast-fed but under more favourable circumstances, has remained a healthy control.

E. H. No. 416. The two elder children were fed at the breast to the age of one year. They are healthy and never showed signs of rickets. The mother was in poor circumstances owing to the war while breast-feeding her third child, from January to October 1918, and the baby did not thrive on breast-milk as the other children had previously. In addition, during the pregnancy with the third child the mother's food was very poor, 'she had to line up for it'.

Meat was only obtained once a week, and margarine only with difficulty. There were also money troubles in the attempt to make both ends meet. She could not obtain either fresh milk, stout, or eggs. Signs of rickets were found when the baby was nine months old, at which age the child was weaned owing to the mother's illness. The father is a waterside labourer, the mother occasionally works as an office-cleaner when he is out of work.

F. W. No. 87. The father is a casual labourer invalided from the army for shell-shock. During the mother's pregnancy financial difficulties were present on and off all the time, and on this account she was unable to obtain sufficient nourishment. 'I was worried over a lot of things both before and after the birth of the baby ; my husband had an accident and there was a sudden death in the house which upset me.' Money shortage began when the mother became pregnant, and that trouble has been present, more or less, ever since. During the pregnancy she was getting up daily at 4.30 a.m. in order to go to work, as her husband was a casual labourer at the docks. Both during pregnancy and lactation she was anaemic, lacked energy, and was always tired. 'I don't think that the breast-milk satisfied the baby, but I managed to keep on with it until he was ten months old.' Signs of rickets were present at that age and became more marked during the next six months, as the food of the family was of poor quality and money troubles continued.

E. W. No. 456. The boy is illegitimate, but the mother says that her pregnancy was uneventful, her general health remained good, and she did not take drugs in order to terminate the pregnancy. The boy was born at term, and at that time the breasts were full and there was plenty of breast-milk. Breast-feeding was continued until the age of eight months and subsequently continued to the age of ten months with the addition of two feeds daily of sweetened condensed milk.

Before the child was seven months old signs of rickets had appeared. Throughout the whole of lactation the mother was very short of money and very often short of food herself.

(*b*) Prolonged breast-feeding . . 51 cases

The term 'prolonged breast-feeding' implies that lactation was continued after the baby was 12 months old.

In seven cases breast-feeding was prolonged until the age of 24 months, and one of these children still received one breast feed nightly until the age of 3 years.

Various reasons were responsible. In some instances lactation was continued on account of the war-time food shortages then prevalent, but in the majority of cases breast-feeding was continued during the second year for no other reason than in order to avoid the purchase of cow's milk, the income available for the food of the older members of the family being already insufficient.

The following are notes and quotations explanatory of these cases :

W. W. No. 362. Breast-feeding was employed until the age of sixteen months (January 1919), when signs of rickets with deformities were present. Up to that age practically nothing else was given ; the mother says that she deliberately continued breast-feeding until January 1919 on account of the prevailing war food shortages. After the boy was weaned he received the ordinary house diet without any fresh milk—condensed sweetened milk, sometimes full cream and sometimes skimmed, was used—and no fat other than margarine. During this period from the age of sixteen months to the age of twenty months the rickets became more marked.

Two elder children had been breast-fed successfully up to the age of ten months prior to the war ; there had been no difficulties with their diet subsequently and no signs of rickets developed.

H. A. No. 98. He was the fifth child of a family of five children, and he was breast-fed to the age of twenty-two months in all. This lengthened period of breast-feeding was due to the mother's difficulty in obtaining family rations.

From the age of ten months onwards, when signs of rickets were first noted, the breast-milk was supplemented with a general war-time dietary which included sweetened condensed full-cream milk. Very little margarine, dripping, or bacon fat could be obtained, and rachitic deformity became more marked during the second year of life. The mother admitted that she was often short of food herself during both pregnancy and lactation.

The three elder children were breast-fed successfully to the age of twelve months, and from that age onwards they received a general dietary with fresh milk. The fourth child was also breast-fed to the age of twelve months, and from that age onwards he received a general war-time dietary (summer 1916) which included half a pint of fresh milk daily as a maximum, never more than that amount. Only half a pound of margarine could be obtained per week for the entire family, even after waiting for hours. This fourth child developed rickets shortly after the age of twelve months. When rationing schemes were started, in January 1918, a quarter of a pound of margarine was obtained as a rule for each member of the family, but at times none at all, and no other form of fat. Milk was only obtained with great difficulty, at most half a pint daily, the parents and elder children using condensed milk of varying quality.

R. B. No. 7. She was the younger child of a family of two children, and was breast-fed to the age of eighteen months, owing to the difficulty that the mother had in obtaining milk during war-time. At that age there were only two teeth and signs of rickets had already appeared. From the age of twelve months a war-time dietary was introduced, but the child ate very little until the age of eighteen months (August 1918), when she was weaned, and a general war-time diet was started which never contained more than half a pint of milk, and sometimes even that quantity was unobtainable.

The elder child was breast-fed to the age of eleven months successfully, and from that age received a general dietary which included a pint of fresh milk until he was nearly three years old, when the amount was diminished.

During the second pregnancy and lactation the food of the mother compared unfavourably with that which she had obtained during her first pregnancy and subsequent lactation.

H. E. No. 160. A family of six children. The three elder children showed no signs of rickets. They were fed at the breast for about nine or ten months, receiving fresh cow's milk by bottle in addition to and after conclusion of breast-feeding. The three younger children, who all developed rickets, were also breast-fed, but the mother volunteers the statement that she was short of food herself both for pregnancy and lactation, in the case of the fourth and fifth children, by reason of the father's unemployment, and in the case of the sixth child (H. E.) as a result of the war. The fourth and fifth children during the later months of lactation received additional feeds of sweetened condensed full-cream milk; they were weaned at the age of one year, when signs of rickets were present. The sixth child, H. E., was breast-fed in all to the age of twenty-four months, owing to the difficulty of obtaining milk during the war. Signs of rickets appeared during the first year, and became much more marked during the second year. Subsequently the child did not walk until the age of 2½ years, and recovery was very slow owing to the prevailing war-time food shortages. During her pregnancy with this child, H. E., the mother suffered for about three months with hyperemesis, and on this account she very often had little to eat until late in the day; financially the family were in better circumstances than during the fourth and fifth pregnancies, when the mother was obliged to go to work and was short of food during both pregnancy and lactation.

L. V. No. 33. A baby girl who was breast-fed to the age of fourteen months. There was plenty of breast-milk and the baby took it well. The mother's health was satisfactory during both pregnancy and lactation, but she became pregnant again when this child, L. V., was nine months old, and continued breast-feeding until she was five months pregnant, when L. V. was fourteen months old. At that age early signs of rickets were present; the child was weaned and fed with a general diet containing about ℥xv of fresh milk daily maximum. Owing, however, to money shortage, which persisted until the child was twenty months old, the mother was often unable to buy fresh milk, she used instead a brand of sweetened condensed milk, and until the child was twenty-two months old condensed milk was used more often than fresh milk. Signs of rickets became more marked during the second year of life, while the child was receiving a general dietary (July 1919 to July 1920). Sugar was given freely both with oatmeal and in milk, as she refused them if not sweetened. Sugar is even added freely to bread and milk made with sweetened condensed milk. 'The mother considers that she may have 3 ounces of sugar daily with her food, a total of about $1\frac{1}{2}$ lb. weekly.' Improvement in the child's condition followed rapidly on a rectification of the balance of the diet, the substitution of butter and dripping for margarine, of fresh milk for condensed milk, and the almost complete elimination of sugar from the dietary. A younger child (control) was subsequently fed by breast to the age of twelve months and thereafter on a general diet containing butter, dripping, and fresh milk, under supervision of a Welfare Centre, without developing signs of rickets.

G. J. No. 330. A baby boy who was breast-fed until the age of seventeen months. The mother was in good health during her pregnancy (January to September 1918), which was only disturbed in the earlier months by air-raids. She was short of money during both pregnancy and lactation, as the father had been invalided from the army, without pension (D.A.H.), after only nine months' service, returning to casual labour. When the boy was nine months old the mother again went to work as a laundress, and continued to breast-feed her baby. Extras were started early, and 'potato formed a large part of the child's diet after the age of ten months'. Signs of rickets appeared before the child was weaned. Money difficulties have continued, on and off, ever since the father joined the army, so that the mother is more often at work than not, her married sister caring for the children by day and cooking the meals.

W. McD. No. 49. A baby boy who was breast-fed until the age of sixteen months. Up to that date (May 1919), when signs of rickets had appeared, the child had little else except an occasional nursery biscuit with sweetened condensed milk, as 'there was plenty of breast-milk'. After the boy was weaned he was given a general diet which included a variable amount of fresh milk, but a very definite excess of sugar. He refused fat as an item of diet, and would only drink milk when sweetened. 'He is very fond of sugar. Bread and sugar is his favourite food.' The mother bought $3\frac{1}{2}$ lb. of sugar weekly as the family ration for seven, and this boy received more than half of the weekly ration during his second year of life. After weaning, his deformities became much more marked: he could not stand until the age of 2 years, and at the age of $2\frac{3}{12}$ years his weight was only 22 lb., and his height $29\frac{1}{2}$ in., stem $18\frac{1}{4}$ in.

The mother's home is a Gloucestershire farm and even during the war the family living in Camberwell were never without butter, dripping, and eggs. The family food budget was not short of fat during the boy's second year of life, January 1919 to 1920, as the supplies from the country continued.

Of the four other children in the family, the three elder were successfully fed to the age of twelve months at the breast and thereafter received a general diet including fresh milk and fats. None of them showed any personal dislike for fat, and they differed in this way markedly from the fifth child, W. McD. above. They never developed signs of rickets.

The fourth child, F. McD., developed rickets. She also was fed at the breast until the age of twelve months; there was plenty of breast-milk but it did not appear to suit the child. The mother's health had been poor during her pregnancy; she was short of food during both pregnancy and lactation, owing to her husband's unemployment.

D. M. No. 340. A baby boy. Eight months, premature, weighing only 6 lb. at birth. Was breast-fed under supervision of a Welfare Centre to the age of ten months, with a very slowly rising weight, the child not appearing to thrive on breast-milk. The mother was advised to wean the boy at the age of ten months, but she did not do so, and continued breast-feeding until he was fifteen months old, the only other food being a nursery biscuit given twice daily with a little sweetened condensed milk. At that age signs of rickets were present and the boy was weaned. From the age of fifteen months to the age of twenty months he received a general diet including half a pint (maximum) of fresh milk, with dripping and bacon fat occasionally. At the age of two years his weight was 24 lb. and height 31 in.; he was making steady progress with a diet including one pint (minimum) of fresh milk, dripping 1 oz. daily, and cod liver oil ʒiij daily.

C. UNSUITABLE DIET OWING TO MONEY SHORTAGE IN THE HOME.

86 cases. 16·1 per cent.

(1)	Severe deformities . . .	15
(2)	Slight deformities . . .	61
(3)	Prerachitic early signs . .	10

Income per head.	*(1) Severe.*	*(2) Slight.*	*(3) Prerachitic.*
(*a*) Out of work	4	25	9
(*b*) 4/- per head	3	2	...
(*c*) 5/- per head	3	12	...
(*d*) 6/- per head	4	9	...
(*e*) 7/- per head	...	9	1
(*f*) 8/- per head	...	2	...
(*g*) 11/- per head	1	1	...
(*h*) 18/- per head	...	1	...
Totals	15	61	10

Gross income.	
Out of work	38
20/-	1
23/-	1
25/-	2
30/-	8
35/-	7
40/-	9
45/-	4
48/-	6
50/-	4
57/-	2
62/-	4
Total	86

In six of the above cases the mother was engaged in married women's labour, viz:

'Out of work'	3 cases.
8/- per head	1 case.
11/- per head	1 case.
18/- per head	1 case.

Method of feeding.	*Out-of-work.*	*4/-*	*5/-*	*6/-*	*7/-*	*8/-*	*11/-*	*18/-*
	INCOME PER HEAD.							
1. Breast-feeding only	...	1	2	3	3	...	...	...
2. Breast-milk, then fresh milk .	3	...	...	...	...	...	1	...
3. Breast-milk, then Nestlé's sweet condensed.	9	1	8	...	...	1	1	...
4. Breast-milk, then fresh milk, then skim condensed ('Goat' brand) and carbohydrate excess.	12	...	...	3	4	...	...	1
5. Breast-milk, then an 'ordinary diet' with fresh milk, half a pint maximum.	3	...	2	2	1	...	...	...
6. Breast-milk, then Nestlé's 'sweet' condensed milk and Ridge's food.	...	...	...	5	...	...	...	...
7. Breast-milk to four months, then 'Ambrosia', then 'ordinary diet' without fat except one pint of fresh milk.	2	...	...	...	...	...	...	...
8. Breast-milk, then 'Glaxo', then Nestlé's sweet condensed milk, with bread excess, fat deficient.	3	2	...	...	...	...	...	...
9. Breast-milk and Glaxo to three weeks, then fresh milk to nine weeks, then Nestlé's sweet milk to ten months, then fresh goat milk to thirteen months.	1	...	...	...	...	...	...	...

(*continued*):

Method of feeding.	*Out-of-work.*	Income per Head.						
		4/-	*5/-*	*6/-*	*7/-*	*8/-*	*11/-*	*18/-*
10. Breast-milk to two months, then 'Ambrosia' and orange-juice to twelve months, then skim condensed milk, with potato and bread excess.	2	...	...	...	...	...	...	...
11. Breast-milk in all to fourteen months, from nine months ordinary food and fresh milk, half a pint maximum, then Nestlé's sweet milk and fat deficiency.	1	...	...	...	...	...	...	...
12. Fresh milk, sugar and groats .	...	...	...	...	...	1	...	...
13. Fresh milk then a war diet .	2	...	2	...	...	...	...	...
14. Nestlé's sweet milk, then 'war diet' and Nestlé's sweet milk.	...	1	1	...	2	...	...	...
Totals	38	5	15	13	10	2	2	1

Under the heading of 'Finance' are grouped a number of cases in regard to which the more important factor is that of income, the diet being unsuitable and of a very variable quality owing to money shortage in the home. The group is not described under the heading of 'poverty', for when the income falls below a certain level the diet tends to become a starvation one and no rachitic changes ensue. Thus it was more common to find rachitic deformities or early signs of rickets when the wages given to the wife for a family of four children were about 35*s.* weekly (1920) than when the sum for such a household was about 25*s.* weekly (1920).

In almost every case in this group the father was engaged in casual labour or was unemployed; in some cases the problem of married women's labour was operating, and as a result the baby was cared for either by a neighbour or at a day nursery, and the sum paid for the child varied from 3*s.* to 7*s.* weekly.

In 38 cases employment was so irregular that it was impossible to arrive even at an average assessment of income per head, and these have been entered under the heading of 'out of work'.

The term 'income per head' in this group refers to that proportion of wages given by the father or other wage-earner to the mother for housekeeping purposes, and out of this sum it is usual in London for the mother herself to pay the weekly charges arising under the headings of rent, insurance premiums, coal, gas, and 'club' subscriptions for clothing, &c., so that the net income per head available for food purchases is smaller in every case than the sum indicated. Under the conditions prevailing during the progress of the investigation it was found that if the sum given by the wage-earner to the mother for the home of a family including four children not above school age was two pounds weekly (i.e. 6*s.* 8*d.* per head weekly) then the housekeeping problem was one requiring great care if suitable food was to be obtained for growing children. When the wages were below this level difficulties began, and the quality of the food provided for the table showed marked deterioration; there was almost complete absence of dripping, bacon fat, eggs, butter, and fresh milk, from the home table; margarine in small quantities—if at all—was the only form of fat, and a relatively large amount of potato and bread were used in lieu. In fact, after the investigation had been in progress for a few months, given the wages, rent, and other essentials of the family budget, it was often possible to predict the quality of food which would be found in the home, and the homes where dripping was absent from the diet-sheet were those where rickets was found or was likely to occur among the junior members of an increasing family.

Without exception the babies were thin and of small size.

The poorest of such family diets seem to consist of potato, bread, a broth made from odds and ends of bone obtained from a butcher or hawker for an insignificant sum, golden syrup, possibly a little margarine, a decoction of tea-leaves obtained by boiling the leaves repeatedly and a condensed skimmed milk; oatmeal is little used, bread and potato form the bulk of the caloric value of such a diet.

There has been little evidence of deliberate waste of money among the poor. On the contrary, there was every indication that a rise of wages or an increase of employment from three days to five days a week in the case of a waterside labourer was immediately followed by better food for the family—that is to say, practically all the money increase went on to the table and was spent especially in dripping, bacon, eggs, butter, fresh milk, and a 'meat dinner' daily.

It is in particular for this social type of family that evidence was obtained so often of the real benefit resulting from the work of the Welfare Centres, both in the treatment and cure of active rickets and in the prevention of further cases in the home. Frequently it was found that where the fifth and sixth children had been rachitic the seventh and subsequent children, who alone had been under the care of a Welfare Centre, were free from rickets.

During the fall of 1919, when the price of fresh milk in London first rose from 8*d.* to 1*s.* per quart, at least 50 per cent. of the families then under observation stopped buying fresh milk entirely, and confined their purchases to tinned condensed milk of various brands. In several cases prerachitic signs appeared, but the onset of rickets was checked by the supply of fresh milk or dried milk by the Welfare Centres, either free or at a reduced price.

Out of 86 cases in this group, in 71 instances the income per head did not exceed 6*s.* weekly, in 10 instances the income per head lay between six and seven shillings weekly, and out of these sums all the expenses of the home were met. Two cases occur at 8*s.* per head, two at 11*s.* per head, and one case at 18*s.* per head, the last being one of the few examples where the money should have been adequate for the family but for the father's intemperance. Additional notes are given below with details of these last five cases.

With regard to the method of feeding employed for the cases in this group it will be noticed that among fourteen different methods of feeding described prior to the onset of rickets breast-feeding appears in eleven, which include 77 cases, but of these in 56 cases the baby had been weaned and the diet employed included a sweetened condensed milk when signs of rickets appeared. Of four cases where the baby had been weaned to fresh milk, in three the families are classified as 'out of work', and the amount of fresh milk given was undoubtedly very variable, being dependent upon the possibilities of employment for the wage-earner. In many other instances the mother was not ignorant of the correct method of feeding her baby, but necessity had driven her to use the cheaper food. Similarly, in the ten instances where breast-feeding was being employed when signs of rickets appeared, in none could it be said that the food of the family was suitable and adequate for a nursing mother with a family of children who were not above school age. As mentioned above, the all-important factor responsible for the cases of rickets in this group is one of money, and a consideration of the matter tends to explain the occurrence of rickets in the younger members of a family the older members of which had not been rickety. Almost invariably the parents attributed the incidence of rickets to the fact that the family had increased out of all proportion to the income available for purchase of food, and the younger members on this account alone, and not from ignorance of mothercraft, had not been so well fed as the elder children.

Additional notes are appended explanatory of the five cases where the income was at least eight shillings per head.

Explanatory notes. Cases. 8*s.* per head minimum.

1. E. W. Mother a war widow with four children. Pension £1 13*s.* 9*d.* She also makes a little money by doing odd jobs for neighbours. Total income £2. Out of this total a rent of 9*s.* 7½*d.* for a fourth-floor three-roomed tenement is paid. The eldest child is 10 years old. E. W. was breast-fed to the age of nine months, thereafter he received a general war-time diet without any fresh milk until he was 3 2/12 years old (April 1919), when butter was obtained occasionally, and not more than half a pint of fresh milk daily. Signs of rickets appeared when the child was eighteen months old, at which age he began to walk and deformities appeared. These symptoms became more prominent after an attack of diphtheria at the age of 3 years.

The three elder children were all breast-fed successfully and subsequently received a house diet (pre-war) containing fresh milk and butter. They never developed signs of rickets and are sturdy well-grown children. At that time the mother had 30*s.* weekly for housekeeping money (pre-war). During her pregnancy with E. W. the mother's food was mostly Quaker oats and she had to line up in order to obtain supplies—often unsuccessfully. Both during pregnancy and lactation (E. W.) her food was not so plentiful or of so good a quality as was the case with the earlier pregnancies.

Assessed at 8*s.* per head.

2. H. C. Mother and three children—father away. Income 34*s.*, out of which a rent of 8*s.* 6*d.* for two rooms is paid. Eldest child is 12 years old. H. C. was fed upon fresh milk, sugar, and groats until the age of twelve months as breast-feeding was only possible for fourteen days, the mother having had insufficient food during her pregnancy. H. C. developed signs of rickets at twelve months. After that age he received a general diet containing dripping occasionally and half a pint (max.) of fresh milk daily. The signs became somewhat more marked during the second year; he was 1½ in. subnormal height at 2 years of age. During the first year he received a pint of fresh milk daily, this was diluted with water, and groats with sugar was added. Sometimes the milk could not be obtained owing to money shortage.

Assessed at 8*s.* per head.

3. E. S. Age sixteen months. Breast-feeding was given in all up to the age of fourteen months. From the age of eight months three breast-feeds were

given daily, with additional feeds of sweetened condensed milk with bread and bread with margarine. The boy began to walk at the age of eleven months. At the age of twelve months deformities appeared, and at the age of sixteen months there was considerable enlargement of the epiphyses. The father is a soldier—away. Separation allowance 23*s*. (February 1920). The following are the notes—verbatim: 'The mother has evidently been underfed ever since she came to London twelve months ago, having meat only twice a week and often denying herself her dinner in order that the child might have enough. In spite of her semi-starvation she had always a large secretion of breast-milk for the child. The home is very neat and clean and the baby is well cared for. In addition to the weekly charges of: Rent 5*s*., Clubs 2*s*. 6*d*., Insurance 9*d*., there is also a weekly hire charge for furniture of 5*s*., total 13*s*. 3*d*. weekly, leaving only 9*s*. 9*d*. for mother and child.' Tenement—two rooms. Mother and child only.

Assessed at 11*s*. per head.

4. C. P. Severe deformities. Father, age 65, a hammerman employed by a motor-cab company. His work is irregular but it is also said that the man is lazy. When in regular work he gives 40*s*., and the eldest son, a boy aged 17 years, gives 7*s*. The mother is always at work herself or she 'would not be able to make both ends meet'. She earns 17*s*. weekly from office-cleaning, and returns to work three weeks after her confinements. There have been five children, three are alive. The family have lived for twenty years in the same two rooms on the third floor of a Southwark house. C. P. was weaned at the age of three weeks and thereafter left in the care of a neighbour. Fresh milk was obtained for the boy from a milk depôt, but there is no means of knowing how much of the milk provided was given to the boy. Before he was a year old he was given a general house diet (war-time) without any supervision as to quality.

Assessed at 11*s*. per head. Gross income average 57*s*. weekly.

5. G. F. The father is a labourer who was exempted from army service on account of defective vision. He gives 32*s*. weekly average. The mother earns 25*s*. weekly from 'office-cleaning' and has been at work since G. F. was six months old. G. F. was breast-fed to the age of six months and was then cared for in a nursery to the age of eleven months where she was fed with an uncertain quantity of fresh milk. From the age of eleven months she was fed with sweetened condensed milk, sometimes 'skimmed' variety, and carbohydrate excess, bread and potato, to the age of twenty months. Occasionally fresh milk was given.

Family, only three, G. B. being the only child. Gross income averages 54*s*.
Assessed 18*s*. per head.

The father is 'temperate as a rule but recently has been drinking rather more'.

N.B.—This was one of the few homes visited where there was deliberate waste of money found.

Note. Subsequently another child was born, breast-fed under supervision of a Welfare Centre to the age of eleven months, and weaned to a general dietary with fresh milk. A healthy control, free from rickets at the age of eighteen months.

D. CARBOHYDRATE EXCESS.

24 Cases. 4·5 per cent.

(1) Severe deformities	1
(2) Slight deformities	9
(3) Prerachitic—early signs . . .	14

Methods of feeding. (13)	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
(*a*) Breast-milk, then fresh milk with 'Savory and Moore's' food.	...	1	...
(*b*) Breast-milk, then an ordinary diet with fresh milk and carbohydrate excess—potato, bread, and sugar.	...	3	5

(*continued*) :

Methods of feeding. (13)	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
(*c*) Breast-milk, then an adequate amount of fresh milk with oat-flour, then a general diet deficient in fat.	...	...	1[1]
(*d*) Breast-milk, then fresh milk and Ridge's food, later a 'war-time' diet—fat deficiency.	...	1[1]	...
(*e*) Breast-milk and fresh milk, then Allenbury No. 3 food with diluted fresh milk.	...	1[2]	...
(*f*) Breast-milk, then 'Glaxo' with sugar excess and Nestlé's sweet milk—excess feeding.	1	...	1
(*g*) Breast-milk, then fresh milk and barley water, then potato, bread, and sugar excess.	...	1[1]	2
(*h*) Breast-milk for one month, then fresh milk with barley gruel and sugar excess to twelve months.	...	...	1
(*i*) Breast-feeding, with Nestlé's sweet milk for one month, then Nestlé's sweet milk with margarine added, later bread-sop and sugar to ten months, then a general diet with adequate fat, carbohydrate excess, and Nestlé's sweet milk.	...	...	1[1]
(*j*) 'Cow and Gate' milk to twelve months, ordinary food thereafter with potato and sugar excess, dried milk continued to sixteen months. No fresh milk.	...	...	1
(*k*) 'Glaxo', then fresh milk or Nestlé's sweet milk and a malted food, later potato and bread excess.	...	1[1]	...
(*l*) 'Glaxo' with extra sugar, then an ordinary diet with sugar and potato excess.	...	1[1]	...
(*m*) Fresh milk ℥v to ℥xv daily, later carbohydrate excess and over-feeding with a full diet.	...	...	2
Totals	1	9	14

[1] In six cases the mother was engaged in married women's labour.

[2] F. C. No. 20. Icterus neonatorum.

In this small group of cases the dietetic abnormality prior to the onset of rickets is one of carbohydrate excess. In some cases the child has been grossly overfed or a greedy appetite has been unchecked during the second year of life. In other cases the excess is limited to one form of carbohydrate food such as cane sugar or potato or bread, for which there has been an abnormal craving.

The first point of importance to notice about this group is that out of twenty-four cases, fourteen showed only early signs of rickets and deformities did not develop.

Secondly, the only case developing severe deformities was grossly overfed during the first year, cane sugar and not starch being used in marked excess with a full cream dried milk. After the sixth month additional feeds of a sweetened condensed milk were given as well, at which age the baby was already taking 2½ pounds of dried milk and a pound of cane sugar weekly (G.H. No. 40, *vide infra*).

Thirteen different methods of feeding are described in the series. Sweetened condensed milk appears under three headings—i.e. four cases—and the absence of this form of milk from the diet list indicates correctly that money shortage was not a factor in the homes of the families in this group. Erroneous conclusions might possibly be drawn from the fact that patent foods figure also only three times—i.e. three cases—but it must be remembered that the period of the investigation followed immediately after the war when the price of these food compounds remained high; moreover the mother could always obtain dried milk of good quality at cost price at any Welfare Centre if it was necessary for her to hand-feed her baby, and in any case the sale of these more expensive patent foods is always greater in suburban districts where wages are higher, where the occupation of the wage-earner is a regular one, and where life as a whole is not precarious. This fact is emphasized in the series of cases collected before the war between the years 1905 and 1914, when out of 108 cases of rickets collected from suburban districts of London, in 61 cases patent foods had been largely employed during the first year of life, whereas out of 205 cases living in waterside districts, where casual labour was predominant, in 123 cases a sweetened condensed milk had been given at the same age. The great majority of severe cases of rachitic deformity were found among the 123 cases above mentioned with homes in waterside districts.

A good deal of attention is being directed at the present time to the incidence of rickets among children who are 'overfed' with a too generous dietary, but it should be remembered that it is most unusual to find severe cases of deformity in such a group, and that when such deformities occur it is very possible that there is a hereditary disability in respect to bone building. In any case the actual numbers obtained for such a group will be small compared with those of far more severe stages of disease found in poor industrial districts.

A consideration of the above facts shows the importance of working in a wide field when dealing with such a subject as rickets, for the type of case commonly seen varies immensely in different residential districts of the same town, as do also the general methods of infant feeding practised by the mothers, whose ideas on the subject are influenced very largely by the amount of money at their disposal after the expenses of the older children of the family have been met.

Individual tolerance for carbohydrate shows considerable variation among children, as is the case with adults, and it is difficult, therefore, to draw a definite line which will indicate the limit above which carbohydrate intake should not pass between the ages of nine months and two years, but in the group of cases here collected the carbohydrate of the diet is out of all proportion to the protein and fat constituents.

'Sugar excess' in the list of methods of feeding indicates that in the first year of life all milk—whether fresh milk, dry milk, or sweetened condensed milk—was sweetened with additional cane sugar, using ¾ to 1½ pounds of sugar weekly, and that the practice was continued during the second year with a general dietary which also contained a large proportion of sugar. The following are verbatim remarks made by the mothers of such children:

'She will never drink her milk unless it is very much sweetened.'

'The child will not eat bread and butter unless it is spread with sugar.'

'She has certainly been very "heavy" on sugar since she was six months old.'

Similar abnormal hunger for bread and potato food characterizes other cases of the series:

'The mother says definitely that the child, now two years old, eats too much, as at meal-times she will often eat her sister's portion as well as her own. To-day she had eaten her own breakfast and also her sister's, which consisted of Quaker oats, milk, sugar, bread and margarine with treacle. She had a meat pie at eleven o'clock and a large dinner at one o'clock, which included potato, gravy, green peas, and rice pudding.'

The clinical type of child who has been overfed with a large diet containing excess of carbohydrate is easily recognized. The complexion is pale, the subcutaneous fat and muscles are flabby, the muscular power poor, the abdomen is much distended, the distension being due to excess gas formation in the coils of the small intestine. The skin is often eczematous. The temporary teeth decay early and the incisors in particular fall out before the child is 4 years old. There seems in some children to be an undue tendency to catarrhal infections, but this is not invariable and its presence is associated with post-nasal obstruction and a high and narrow hard palate. Such a tendency to catarrhal infection is responsible for the sayings of a grandmother whose wisdom was thus quoted by the mother of a non-rachitic child: 'Babies who have too much sugar become stuffy on their chests'.

As mentioned above, the type of rickets seen is more often in an early stage without development of deformities, the skiagrams show only a fluffiness of the epiphysial lines which does not subsequently develop the extensive cupping and 'crater formation' appearance that is so characteristic of those advanced cases of rickets resulting from a diet in which fat deficiency is associated with carbohydrate excess.

Of the twenty-four cases, only five were up to normal standards of height and weight for age. In all of these five cases the signs were in the early stage. Thus:

G. B.	No. 11.	13 months old.	Weight 22 lb. 8 oz.	Height 28½ in.	Prerachitic.
W. W.	No. 387.	15 months old.	Weight 25 lb. 12 oz.	Height 31¾ in.	Prerachitic.
C. B.	No. 146.	18 months old.	Weight 24 lb. 12 oz.	Height 33 in.	Prerachitic.

In nineteen cases, in spite of the high caloric value of the diet, the readings of height and weight for age were subnormal. Thus:

K. S.	No. 484.	15 months old.	Weight 20 lb. 12 oz.	Height 29 in.	Prerachitic.
J. B.	No. 248.	16 months old.	Weight 21 lb. 10 oz.	Height 30 in.	Prerachitic.
J. H.	No. 480.	17 months old.	Weight 22 lb. 4 oz.	Height 29 in.	Prerachitic.

D. M.	No. 208.	19 months old.	Weight 22 lb. 0 oz.	Height 30 in.	Slight deformity.
C. W.	No. 360.	21 months old.	Weight 23 lb. 12 oz.	...	Slight deformity.
H. W.	No. 82.	2 years old.	Weight 18 lb. 8 oz.	Height 29 in.	Slight deformity.
D. F.	No. 34.	2 years old.	Weight 22 lb. 12 oz.	Height 30½ in.	Slight deformity.
G. H.	No. 40.	3 years old.	Weight 21 lb. 4 oz.	Height 33 in.	Severe deformity.
L. P.	No. 262.	3½ years old.	Weight 31 lb. 0 oz.	...	Prerachitic.

The excessive sweating which is such a marked symptom of those cases of rickets where there is fat deficiency with carbohydrate excess in the diet is not by any means so common in this group where the abnormality of diet, apart from its high caloric value, is one of carbohydrate excess.

In two instances there were signs of rachitic deformity in one or other parent, but owing to the evidence of bad dietary for a considerable period they were not indexed under the heading of 'diathesis' and only a cross-index note was made.

The urine of all these cases was obtained and tested for sugar on at least one occasion, in some cases the urine was tested several times. Glycosuria was never found.

The following are the notes of the case with severe deformities:

G. H. No. 40. A boy. The mother had very little breast-milk. Breast-feeding was practised for three weeks, with extra feeds of fresh cow's milk. Secretion then failed and the child was weaned. He was then fed by bottle on 'Glaxo'. The 'Glaxo' was used double strength because the child was fretful and did not seem satisfied. Sugar was also added from the first, and the amount of sugar was increased as the feeds became larger. In addition extra feeds of Nestlé's sweet milk were given because the child cried so much. The baby was fed in this way until the age of nine months when the child was taking 2 to 2½ lb. of 'Glaxo' weekly with 12 to 16 oz. of sugar, besides extra feeds of Nestlé's sweet milk. Rickets was diagnosed at a children's hospital at the age of nine months.

After the age of nine months fresh milk was given instead of 'Glaxo'; it was always sweetened with cane sugar, and extra feeds of Nestlé's sweet milk were continued until the age of 2 years. During the second year signs of rickets became more marked, but fresh milk was never discontinued from the age of nine months to the age of three years, at least one pint of milk, with cane sugar added, being provided for him.

At the age of fifteen months, bread and milk and milk puddings made with margarine or butter were introduced, this being his first solid food. He has never been fond of fats such as margarine, butter, or bacon fat, and these have been disguised in various ways or attempts have been made to do so in order to include them in his diet. He has always taken milk well without any difficulty, but it was not until he was 2½ years old that his early dislike for butter, dripping, and margarine disappeared. From the age of eighteen months he was taking 'ordinary food' with a good deal of sugar, as sugar was always spread upon bread and margarine or upon bread and butter. Total sugar, 1 to 1½ lb. weekly besides that used for cooking.

The signs of rickets were well marked. The head of typical rachitic shape. The fontanelle did not close until he was nearly 3 years old. Dentition was delayed. All the teeth erupted, but at the age of 3 years the four upper incisors which had been very carious were removed, and four temporary molars, also very carious, required treatment. The sternum was prominent with a rachitic 'rosary', the lower ribs were 'beaded', and there was a 'Harrison's sulcus'. Both lower radial epiphyses were markedly enlarged; the lower tibial epiphyses were enlarged. Antero-external bowing was present in the lower thirds of both tibiae, especially of the right tibia. The abdomen was very prominent, owing to much excess of gas.

The muscles, in general, were poorly developed, flabby, and weak. Normal reflexes were found.

A systolic murmur was heard over the mitral area, of organic character, but the heart was not enlarged, and there had been no signs of cardiac failure or insufficiency.

Neither father nor mother showed signs of old rachitic trouble, and they gave no history of it, but the mother's brother and her uncle had suffered from rickets, and also her sister's child. No other cases among relatives were known.

Note.—A baby was subsequently born when the above boy was 3½ years old. This baby was watched as a control. Breast-feeding was employed until the age of twelve months under the supervision of a Welfare Centre, and subsequently the child was fed upon fresh milk and a general diet containing butter and dripping. This baby remained a healthy control at the age of 2 years. There were no other children.

(2) Factors other than diet.

E. 'DIATHESIS.'

39 Cases. 7·3 per cent.

(1) Severe deformities	7
(2) Slight deformities	27
(3) Prerachitic—early signs . . .	5

Methods of feeding. (17)	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
(*a*) Breast-feeding alone	1	3	1
(*b*) Breast-milk, then fresh milk and adequate fat in the diet.	...	10	1
(*c*) Breast-milk, then fresh milk and adequate fat with sugar excess.	1	2	...
(*d*) Breast-milk, then Nestlé's sweet milk, then fresh milk with adequate fat in the diet.	..	3	...
(*e*) Breast-milk, then fresh milk with Ridge's food and sugar.	...	1	...
(*f*) Breast-milk, with Nestlé's sweet milk and Robb's biscuit.	...	1	...
(*g*) Breast-milk with fresh milk, then Nestlé's sweet milk and 'ordinary food'.	...	1	...
(*h*) Breast-milk, then 'Glaxo', then fresh milk, then a 'war-time diet' with fat and sugar deficiencies.	...	2	...
(*i*) Breast-milk, then diluted 'Glaxo', then peptonized milk, then fresh milk or 'Glaxo' with an adequate fat diet.	...	...	1
(*j*) Breast-milk or 'Glaxo' to two months, then Nestlé's sweet milk with lime-water to eleven months, then an adequate fat diet with Nestlé's sweet milk.	...	...	1
(*k*) Breast-milk to seven weeks, then 'Glaxo' to ten months, then Allenbury No. 3 and fresh milk with satisfactory diet.	...	...	1

(*continued*):

Methods of feeding. (17)	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
(*l*) 'Glaxo', then Nestlé's sweet milk and adequate fat.	...	1	...
(*m*) 'Glaxo', then sugar excess with adequate fat.	2	...	...
(*n*) Fresh milk, sugar excess, adequate fat.	1	1	...
(*o*) Allenbury No. 1, then fresh milk and cream, then a general diet with fresh milk.	1	...	...
(*p*) Nestlé's sweet milk	1	1	...
(*q*) Fresh milk, then 'Ambrosia' .	..	1	...

Under this heading are collected a group of cases which are characterized by the fact that there is a family history of rickets, and that symptoms of the same disorder had appeared in the child under observation irrespective of faulty dietary or defective environment. Children of such families undoubtedly may develop rickets irrespective of any fat deficiency or carbohydrate excess in the diet and while living an open-air country life.

Only those cases have been included in this group in whose families rickets had been present in either father or mother and the signs of it were still obvious owing to the severity of old deformity, but it is extremely probable that a rachitic diathesis is more widespread than at first appears from the records collected. In adult life an inherited tendency to early and excessive precipitation of calcium salts about joints, in muscles, and in the walls of arteries is generally recognized, and dietetic factors are considered to predispose at times to such changes. It does not seem unreasonable, therefore, to suppose that during the age of infancy a tendency to delayed or deficient precipitation of insoluble from soluble calcium may also be an inherited defect, and that such a defect may also be much influenced by abnormality or irregularity of diet as would seem to be the case in rickets.

It is easy to understand why such an hereditary defect should first show itself at about the age of twelve months. During the first year of life the child grows eight inches in height, most of this increase being in the lower limbs rather than in the trunk. During the second year growth continues for another four or five inches, but after the age of two years there is usually an interval of five or six more years before another twelve or thirteen inches have been added to the height. Any defect, whether of delay or deficiency, in ossification would naturally show itself more particularly during the period when growth of bone and multiplication of bone-forming cells are more rapid, and at such a period the effects of a curative nature might be delayed until a slower rate of growth supervened, unless some intensive form of treatment were adopted.

Methods of feeding these 39 cases have been classified under seventeen headings, and seven of these subdivisions dealing with twenty-one cases detail satisfactory diets, the subdivisions in question being: *a, b, i, k, l, o,* and *q* (*vide supra*).

Seven of the cases developed severe deformities, in five of these sugar excess in the diet was admitted by the mother, viz. subdivisions *c*, *m*, *n*, and *p* (*vide supra*). A sixth case, with severe deformity, developed signs of rickets while the child was being breast-fed, but after weaning sugar excess appeared in the diet and the symptoms became more severe, subdivision *a* (*vide supra*). The notes of this last case are as follows:

J. R. No. 349. A baby boy, who was breast-fed until the age of nine months. At that age, as he had not really thrived from birth and only weighed 11½ lb., he was taken to hospital and rickets was diagnosed, typical X-ray appearances being present with early enlargement of the epiphyses.

The child was weaned to a diet of fresh milk and malt, with two feeds, night and morning, of Mellin's food, a total of 1½ pints of fresh milk being provided daily until the age of thirteen months, when considerable progress had been made and he was no longer brought to hospital. From the age of thirteen months to the age of 2$\frac{3}{12}$ years fresh milk was never discontinued. The maximum amount daily was one pint, and this was always sweetened with cane sugar or he would refuse to drink it. Furthermore he always had sugar on margarine and bread as 'he would not touch it without'. The mother says that 'he prefers his food sweet, he is very fond of sugar, and he has more than his share'. During this period the deformity increased considerably, and when he was again brought to hospital at the age of 2$\frac{3}{12}$ years the deformities were severe and the child's weight was 20 lb., height 29 in., stem height 16¾ in.

With a satisfactory diet his general condition improved, and at the age of 3$\frac{9}{12}$ years his weight was 29 lb. and the height 32 in.

The father of the child and the father's brother suffered from rickets as children, and instruments were required for deformities of the legs.

This group of 39 cases—as a whole—are characterized by the fact that they do not thrive from very early days, and in seven instances the symptoms were congenital, the bones were soft and deformed at birth, and at an early date X-ray appearances at the epiphysial lines were typical of rickets. Four of the cases suffered for varying periods from a primary dyspepsia during the first eight months of life, receiving on this account expert treatment and advice from hospital physicians. These have received a cross-index note in the Gastro-intestinal group (*q.v.*), but are not included in the cases collected under that heading because the factor of diathesis seemed to be more important.

The fact that in certain families the children 'make bone badly' —as is the colloquialism—is widely recognized among members of the industrial classes, and such knowledge explains the apparent apathy and indifference to rachitic deformities in children which is sometimes displayed by their parents. 'His father and grandfather had rickets and they grew out of it' is a statement often made as an excuse for neglect.

The experience which is obtained as the result of many years of hospital work among children emphasizes the fact that among families of this type no liberties can be taken with the diets of children under the age of five, and that a disturbance of dietetic balance, which would produce little effect for a child with a healthy family history, will probably produce marked signs of rickets among those who belong to what may be termed a rachitic diathesis. It will be noticed that for the number of cases recorded in this group the percentage of severe deformities is high.

The following notes are typical of cases in this group :

H. G. No. 32. Age $1\frac{8}{12}$. A baby girl with severe rachitic deformities. There are two other children in the family, ages 6 and 5 years respectively. The father is a tailor who has been invalided from the army. The mother is a blouse maker and manages a small shop for selling purposes, but until $2\frac{1}{2}$ years ago (April 1917) she kept a confectioner's shop, which trade was discontinued on account of war shortages of sugar. The maternal grandfather is a provision dealer, and the mother has never at any time been short of food during the past six years. The family have never been rationed throughout the war. They could always obtain fresh milk. Tinned condensed milk has never been used, nor were they without dripping, bacon fat, or butter. If these items of food were wanted they could always be obtained by 'trade exchange' privately.

There is excellent accommodation in the house, which consists of a shop, kitchen, three bedrooms, and a basement cellar. Rent £1 per week. Six years in residence. Situation, Blackfriars Road.

There seems to be no lack of anything in the way of good food, 4 pints of fresh milk are taken daily for the house, and half a pound of fresh butter daily (October 1919). No margarine is used.

The mother, who is still bandy-legged herself and shows typical rachitic stigmata, says that she herself and all her brothers and sisters were bandy-legged as children, but 'recovered' without treatment. The family never suffered from poverty, they belong to the small shopkeeper class. She says that 'the disease of rickets is in the family, but they grow out of it'. Food has always been good.

Her two elder children, now aged 6 years and 5 years, were rickety when they were younger, as is shown by photographs taken at the ages of 3 years and 2 years respectively, when they were bandy-legged and had enlarged rachitic epiphyses. The eldest boy, aged 6, was hand-fed with fresh milk in the first year. He is a healthy boy and has never had any illnesses. He developed rickets during his second year when he was still taking fresh milk and a general dietary with sugar excess, as the mother was keeping the confectionery shop and he had a great many sweets. His legs are now quite straight though he is somewhat small for his age.

The second boy, aged 5 years, was also hand-fed with 'Glaxo', according to directions during the first year, Robb's biscuit being added as an extra from the age of six months. His diet during the second year still included fresh milk, at least one pint daily, and the house diet, with a definite excess of sugar as in the case of his eldest brother.

Neither of these children were without butter or milk during the war. The baby girl, aged $1\frac{8}{12}$ years, weight 19 lb. 9 oz., was breast-fed alone until the age of nine months, and breast-feeding was subsequently continued, two feeds daily, until the age of nineteen months. From the age of nine months the child has had at least a pint of fresh milk daily, and the diet has also contained butter invariably. She drinks fresh cow's milk readily provided that sugar is added to it, but in the absence of sugar she will not touch it. She is very fond of sugar as an item of diet and 'will eat it in handfuls if she has a chance'. She is described as being 'particular' about her food, but there is no history of recurrent 'bilious attacks', cyclic vomiting, or of diarrhœa suggesting a fat dyspepsia. She is fond of butter and of sweetened milk pudding more especially, but takes a general dietary including cakes and biscuits, potato with gravy, macaroni made up with butter. All her milk puddings are made with butter, sugar, and fresh milk, and those seen at the home were well cooked and appetizing.

At the age of twenty months she had 14 teeth. The first tooth had erupted at the age of four months, and the child could walk with help at the age of nine months. There was a chronic eczematous rash upon the scalp. No deformity of the chest. No rosary.

The lower radial epiphyses were very prominent.

There was well marked rachitic tibial deformity in the lower thirds of each shaft with very prominent epiphyses, and marked genu-varum, the left leg being worse.

She was admitted to the Evelina Hospital for careful dieting and observation on February 9, 1920, weighing 20 lb. 1 oz. (age 2 years), as during the previous four months she had made no progress and had only gained half a pound in weight.

During the first three months in hospital progress was delayed by the impetiginous eczema and abscess formation, but on discharge on June 7, 1920, she had gained 3 lb. 7 oz. in weight (23 lb. 8 oz., $2\frac{4}{12}$ years).

While in hospital the only change in the previous home diet was the complete elimination of sugar; $1\frac{1}{2}$ pints of fresh milk daily and $1\frac{1}{2}$ oz. of dripping daily were included in the hospital diet, which did not contain butter.

The eczematous eruption had completely cleared up, but apart from this her general progress was slow, even with a carefully regulated diet.

At the age of 3 years (February 1921) her height was $32\frac{1}{2}$ in., and weight was 28 lb. The bones were thicker and stronger, the epiphyses were much less prominent. She had gained 8 lb. in weight in the course of one year, her appetite had improved, and though still subnormal in weight and height for age her deficient powers of assimilation of food were not so apparent as before. Very little cod liver oil was used in this case, reliance being placed upon a well-balanced diet in treating the child.

Note. In addition to the 39 cases detailed under the heading of 'diathesis' there are 36 cases classified under other headings because other factors seemed to be more important as exciting causes of rachitic troubles. These 36 cases have been cross-indexed in a separate table (*vide infra.*).

In all of the 75 cases either father or mother or both parents suffered so severely from rickets during infancy that evidences of deformity can still be recognized.

Among the latter the following note was made:

J. A. No. 1. Gastro-intestinal group. 'The mother says that the fontanelle closed late with all her children. She looks upon it as "a family failing and does not worry about it", as her youngest sister, now aged 29 years, had rickets, with bow-legs, which 'grew straight again.'

Diathesis not indexed as such . . . 36 cases.

Either father or mother or both parents show signs of rachitic deformities. In the following instances the cases have been classified thus:

Indexed as.	
Fat deficiency with carbohydrate excess	9 cases.
Breast-feeding	7 cases.
Finance	3 cases.
Carbohydrate excess	2 cases.
Ante-natal	1 case.
Gastro-intestinal	6 cases.
Control cases	8 cases.
Total	36 cases.

F. ANTE-NATAL INFLUENCES.

22 cases. 4·1 per cent.

(1) Severe deformities	Nil
(2) Slight deformities	11
(3) Prerachitic. Early signs	11

Method of feeding.	*Mother very ill during her pregnancy. Hyperemesis.*	*Home troubles. Insufficient food, &c.*	*Abortifacients. Bad health in pregnancy.*	*Antepartum haemorrhage at three months and six months. Poor diet. Anaemia. Dyspepsia.*
(*a*) Breast-feeding only	4	3	...	...
(*b*) Breast-feeding, then fresh milk	1	4	1	...
(*c*) Breast-feeding, then 'Glaxo', then fresh milk	3	1	1	1
(*d*) 'Glaxo', then fresh milk	2	...	...	...
(*e*) 'Glaxo', then Benger's food with fresh milk, later fresh milk.	...	...	1	...

Note.—All these children were of small weight at birth, and from the earliest days made slow progress.

In three of the above cases the mother was engaged in married women's labour.

In this group of cases the important factor is found to be the condition of the mother during her pregnancy.

Without exception the children were of small size at birth, they made slow progress, and signs of rickets appeared before the age of seven months. In many cases the signs were congenital.

No severe deformities occurred owing to the fact that the children came under the observation of Welfare Centres at an early date and efficient post-natal treatment was provided. This supervision also explains the fact that 50 per cent. of the cases never showed more than early signs of rickets without deformities.

The cases are grouped under four headings, which indicate the reason for the mother's ill health during her pregnancy, such as infective disease, accidental complications of pregnancy, nervous worry, whether due to the war or to other causes, e. g. domestic troubles, money shortage, and illness resulting from occupations during pregnancy.

Three voluntary admissions to the use of abortifacients were made, and ill health directly attributed thereto. There have been many indications that the use of abortifacients and other drugs sold for the purpose of terminating pregnancy and for the prevention of conception is much more widespread now than during the decade which preceded the war. On several occasions the reason for this practice was frankly and openly given in the statement that the high cost of living since the war will not permit the possibility of a larger family unless children already born are to suffer.

Methods of feeding the babies in this group have been arranged under five headings. In none of the cases could it be said that the methods of feeding by hand had been unsuitable prior to the onset of rickets, though in some cases a poor diet was given subsequently in later months while signs of rickets became more marked.

In seven cases breast-feeding was given alone.

In twelve cases breast-feeding was supplemented or followed by a diet of satisfactory balance containing adequate fat.

The following are explanatory notes of cases included in the 'Ante-natal' group:

J. B. No. 477. Prerachitic type. Baby boy breast-fed to the age of seven months without any other food, breast-feeding was subsequently continued to the age of twelve months with additional feeds of Benger's food and fresh milk, after which age an adequate diet was given.

The mother had hyperemesis throughout her pregnancy. She was also very much worried by home troubles, and her general health suffered.

The baby was delivered at term but was very small, and made very slow progress for the first nine months. The tibial epiphysial lines showed signs of rickets at the age of six months.

M. E. No. 376. Baby girl. Congenital deformities of tibiae. Breast-feeding alone was given to the age of six months and subsequently continued with extra feeds of fresh milk, bread, and sugar to the age of ten months. The mother is not strong. She had hyperemesis during the last three months of pregnancy, and throughout her pregnancy she had insufficient food owing to money shortage, her husband being out of work.

There was a rapid improvement after the age of ten months, the child being fed with fresh milk—1½ pints daily—by bottle.

H. G. No. 478. Baby boy. Breast-feeding employed alone to the age of seven months, when the child was brought to hospital on account of bowing of the tibiae which had been increasing since birth. X-ray signs of rickets. The baby weighed 18 lb. 5 oz. at seven months and the length was 28 in. (+ normal).

Throughout her pregnancy the mother suffered from hyperemesis, and she lost a great deal of weight. There was no shortage of food but she was unable to retain it. The baby weighed 7 lb. at birth, and after delivery the mother's health at once improved. There has always been a satisfactory secretion of breast-milk, and her appetite has been good with an adequate diet.

J. Mc A. No. 467. Baby boy. Prerachitic type. Breast-feeding was employed until the age of eleven months when the secretion failed. Practically no other food was given up to that age, when early signs of rickets were found.

The mother was in work until she was eight months pregnant in the 'varnish' department of a cigarette-tin factory when she became very ill with colic and anaemia, and she subsequently remained under 'panel' treatment during lactation.

After weaning the child was fed on Nestlé's sweet milk to the age of thirteen months, and subsequently received a general diet with half a pint (maximum) of fresh milk daily. Apart from margarine the diet contained no other fat. Money shortage. Weight 18 lb. 12 oz. at seventeen months.

S. S. No. 474. Baby boy. 'He did not thrive from birth.' When the mother was four months pregnant she was very ill indeed with septic pneumonia, and remained under medical treatment for a considerable time. The baby was born at term but was very small.

Breast-feeding was employed alone for one month when he was taken to a Welfare Centre. From that age until the age of nine months he was fed on alternate feeds of breast-milk and dried milk (either 'Glaxo' or 'Ambrosia'). He made very slow progress. From nine months to thirteen months he was bottle-fed with 'Ambrosia'. Early signs of rickets were present at the age of nine months. During the second year signs of rickets became more marked, the diet contained half a pint (maximum) of fresh milk, and the fat percentage of the diet was somewhat low, dripping being an infrequent item. 3 lb. of jam and 4 lb. of sugar were bought weekly for a family of two parents and five children. Bacon is bought 'occasionally'. 'The family as a whole do not like fat, and the mother therefore does not buy fat meat as it is wasted.' The boy's weight was 15 lb. 9 oz. at thirteen months, and 20 lb. 12 oz., height 31 in. at twenty-four months.

W. T. No. 212. Baby boy. The mother was very ill during her pregnancy. She had a nervous breakdown as a result of the air-raids which were frequent during that time (June 1916 to March 1917). She was never actually short of food, but 'lining up' for rations was a great difficulty, and her general health suffered. The confinement was difficult, being a breech presentation, and the tibiae were deformed from birth.

Breast-feeding was employed alone to the age of six months and subsequently continued to the age of nine months with two bottle feeds daily of fresh milk. At the age of nine months rickets was diagnosed, the tibiae had become more curved, the epiphyses were slightly enlarged, and the epiphysial lines showed early X-ray signs of rickets.

F. B. No. 266. Baby girl. Rickets diagnosed at the age of nine months. Weight 10 lb. 1 oz. During the earlier part of the pregnancy the mother was a great deal upset by air-raids (January–October 1918), but her main troubles were in connexion with 'lining up' to obtain food rations and from the difficulties arising from war-time shortages. Three of her children died in hospital during this pregnancy and the mother herself was ill with rheumatic fever in June 1918, this baby, F. B., being born in October 1918.

Breast-feeding alone was given until the age of six months. After that age alternate feeds of Nestlé's sweetened milk were given with breast-milk. Early signs of rickets (X-rays) were found at the age of nine months.

A. R. No. 347. Baby boy. Weight at birth 3 lb. 7 oz. Throughout the pregnancy the mother's health was very poor (October 1917 to July 1918), air-raids taking place at intervals, more especially during the early months. Food difficulties were considerable, food was insufficient and of poor quality. In addition the mother was much worried about the father's illness—he was ill with 'bronchitis' throughout almost the entire pregnancy. To these various troubles she attributes the small size and poor development of the baby, who was born at term.

The child was breast-fed to the age of ten months; no other food was given. From ten months the child was fed upon fresh milk and Allenbury No. 3 food, using one pint of fresh milk daily, and a general diet. Weight at thirteen months, 13 lb. 4 oz. Early signs of rickets.

D. D. No. 288. Baby girl. Illegitimate child. She was very small at birth and did not thrive upon breast-milk. She was weaned at the age of two months and subsequently fed on 'Glaxo' to the age of twelve months. After the age of twelve months the child received a general diet containing both fresh milk and dripping, but from the time that the child was two months old until the age of two years the mother was engaged in married women's labour, the father, a bus conductor, being on active service.

The mother states that though born at term the child was very weak and puny, and she attributes this fact to the endeavour which she made for several weeks by means of drugs—some of which were very strong purgatives—to terminate the unfortunate pregnancy. She was quite frank about the matter, and gave no indication that her present relations with her husband are unsatisfactory.

Signs of rickets appeared during the first year, and deformities increased during the second year when it is said that the child was taking half a pint of milk with a general diet including dripping which was obtained, even in 1918, from a post-office restaurant where the hands had meals.

At the age of three years the child's weight was only 17 lb. 2 oz. and her height 27¼ in. She subsequently died of laryngeal diphtheria (tracheotomy) at the age of $4\frac{3}{12}$ years, while an in-patient at the Evelina hospital.

M. P. No. 62. A baby girl born at term. Pregnancy was much disturbed by air-raids but there was no shortage of food. The mother's health suffered a great deal owing to the fact that she took drugs to try and terminate the pregnancy. Breast-feeding was only possible for a fortnight, when secretion failed and the child was weaned. Several methods of feeding were then tried unsuccessfully until the age of three months, including 'Glaxo', fresh milk with barley-water, and Allenbury foods Nos. 1 and 2. From three months of age fresh milk with Benger's food was given and the child made considerable progress so far as weight was concerned, but at the age of nine months rickets was diagnosed—early deformity—at St. Bartholomew's Hospital, so a change was made to fresh milk, given undiluted, with great success. Rapid improvement followed and the child weighed 22 lb. 4 oz. at thirteen months.

The mother attributed the weakness and small size of the baby at birth to the fact that for a considerable period during her pregnancy she was taking drugs in the attempt to produce abortion.

L. D. No. 153. Baby boy. Breast-feeding was employed until the age of nine months, when the child was weaned. Weight 12 lb. 9 oz. Early signs of rickets had appeared at that age, and the baby was subsequently fed successfully with 'Glaxo' and later with fresh milk under supervision of a Welfare Centre.

The mother had been in poor health during her pregnancy. For two years previously she had worked at Woolwich Arsenal, and on that account she was suffering from anaemia and debility. Two bad attacks of antepartum haemorrhage at three months, and again at six months, occurred, and though the confinement was uneventful she suffered from haemorrhage for two months during the subsequent lactation. There were no money difficulties during either pregnancy or lactation, as the husband was in regular employment at a good wage, but during lactation she had little appetite for a varied diet and lived chiefly upon tea with bread and margarine, as had been the case for a considerable part of her pregnancy.

Ante-natal deficiencies and influences probably play a larger rôle than would be imagined from the small number of cases included in this group, for they are a contributory factor in causing premature delivery, and in leading to the birth at 'term' of puny, undersized, whining infants, who in the words of the mother 'fail to thrive from birth', who suffer from the primary dyspepsias of infancy with intolerance for fat, and who for that reason both early and late—thoughout infancy and into childhood—are fed upon the diluted sweetened condensed milk for which tolerance is established earlier and which leads in the later months of infancy when growth is active to a succession of evils in vicious circle. It is especially in the supervision of both mother and child during both ante-natal period and infancy that the Maternity and Infant Welfare Centres have justified their organization and proved the immense success of their work.

G. GASTRO-INTESTINAL DISORDERS.

17 cases. 3·1 per cent.

(1) Severe deformities . .	Nil
(2) Slight deformities . .	14
(3) Prerachitic. Early signs .	3

Method of feeding.	*(1) Severe.*	*(2) Slight.*	*(3) Prerachitic.*
(a) Breast-milk, then fresh milk . .	Nil	6	1
(b) Breast-milk, then 'Glaxo' to twelve months, later 'Cow and Gate'.	Nil	1	Nil
(c) Breast-milk, then 'Glaxo', then fresh milk.	Nil	3	Nil
(d) Fresh milk	Nil	2	1
(e) Fresh milk and cornflour, sugar excess later.	Nil	1	Nil

(*continued*):

Method of feeding.	(1) *Severe.*	(2) *Slight.*	(3) *Prerachitic.*
(*f*) Fresh milk, then 'Glaxo' to nine months, later fresh milk with Allenbury No. 3 and a general diet.	Nil	Nil	1
(*g*) Breast-milk with Nestlés sweet milk, then 'Glaxo', then citrated fresh milk, later from twelve months fat deficiency, no fresh milk but excess sugar.	Nil	1	Nil

Note.—In ten of the above cases the mother was engaged in married women's labour.

In this group of cases gastro-intestinal disturbance was present for shorter or longer periods and of recurrent type between the ages of three months and eighteen months, resulting in malnutrition or producing extreme weakness and extreme loss of weight. There were symptoms of general or partial intolerance for solid food or for certain items of diet, diarrhœa of varying severity, usually with bulky undigested motions, excess gas formation in the small intestine, excessive discharge of mucus, occasionally vomiting and colic. The illnesses were characterized by the chronic form of diarrhœa, which in some cases lasted for three or four months; choleraic discharges were unusual.

Two cases subsequently developed tabes mesenterica. In two other instances the symptoms were typical of coeliac disease, and the motions were of the type recognized in that disorder.

Rickets does not appear, in London, to be a frequent sequel of summer diarrhœa. After the summer of 1911, which was by far the worst epidemic of the last sixteen years, 200 recovered cases which had attended a special out-patient clinic for summer diarrhœa at the Evelina hospital were visited and examined at intervals during the eighteen months following. These cases were drawn purposely from a wide South London area, and nearly 50 per cent. were from good class industrial homes. Eleven of these subsequently developed rickets. In none of the eleven did the parents attribute the onset of rickets to the diarrhœa of the previous summer; without exception they had made a satisfactory recovery from the epidemic. Eight of the eleven had been fed upon various brands of sweetened condensed milk.

Prior to that date, from 1905 to 1908, I had attempted to trace a relationship between chronic intestinal stasis and rickets, having previously, as house-surgeon to Sir Arbuthnot Lane, seen many of the ill-effects resulting from stasis so severe as to demand operative treatment, but neither as an exciting nor as a predisposing cause could any evidence of an important nature be obtained of such relationship.

Further, among 330 cases of rickets collected between the years 1905 and 1914:

1. Of 219 riverside cases (casual labour districts).
    In 149 the bowels were regular and had given rise to no trouble.
    In 33 there had been occasional constipation.
    In 11 there had been occasional diarrhœa.
    In 26 no statement was obtained.

2. Of 111 'outer ring' (suburban) cases.
   In 71 there had been no irregularity of the bowels.
   In 25 there had been more or less trouble with occasional constipation.
   In 9 there had been occasional diarrhœa.
   In 6 no statement was obtained.

In the present series of cases under review, between 1919 and 1921, 533 in number, no importance can be attached to the occurrence of chronic intestinal stasis as a clinical feature.

The extreme degree of malnutrition or wasting among cases in this group is obvious from the following data:

J. A.	No. 1.	13 lb. 2 oz. at 14 months, 21 lb. at 21 months. Subsequently 29 lb. at $2\frac{7}{12}$ years.	Slight deformities.
L. C.	No. 92.	23 lb. 12 oz. at 22 months.	Slight deformities.
C. F.	No. 405.	20 lb. at 17 months, 21 lb. at 24 months.	Slight deformities.
V. G.	No. 406.	14 lb. 5 oz. at 12 months.	Slight deformities.
V. H.	No. 253.	14 lb. 8. oz. at 16 months, 18 lb. 4 oz. at 24 months.	Prerachitic early signs.
J. H.	No. 58.	16 lb. 3 oz. at 24 months, 20 lb. 8 oz. at $2\frac{4}{12}$ years. Height $31\frac{1}{2}$ in. at $2\frac{4}{12}$ years. Coeliac disease.	Slight deformities.
N. P.	No. 471.	13 lb. 1 oz. at 15 months. Height $28\frac{1}{2}$ in at 15 months. 16 lb. 4 oz. at 21 months. Scurvy.	Slight deformities.
V. P.	No. 344.	13 lb. 13 oz. at 24 months, 21 lb. 4 oz. at 4 years. Coeliac disease.	Slight deformities.

Methods of feeding. These fall into seven groups.

In two instances the method of feeding was unsatisfactory. In one case there was an excess of carbohydrate in the diet—cornflour and sugar—with one pint of fresh milk daily; in the second case after the age of twelve months no fresh milk was given, and a condensed sweetened milk was used with additional sugar in large quantities with a general diet of poor quality. In both of these cases, however, intestinal symptoms lasted for at least three months, and formed the main clinical feature of the case until signs of rickets appeared.

In the remaining fifteen cases the quality of the diet was satisfactory and the method of feeding was rational. It is possible, however, that the care given to the child in the home was indifferent and supervision irregular, for in ten out of seventeen cases the mother was engaged in married women's labour, so that a considerable part of each day was spent away from her home, and the baby in question was in charge of a neighbour or deposited at a nursery during certain hours.

Gastro-intestinal symptoms were troublesome mostly between six months and fifteen months; nine of the seventeen suffered from troublesome diarrhœa between six months and twelve months. There were no severe deformities among the cases in this group.

Prevalence of gastro-intestinal symptoms. 17 cases.

Age.	*Slight deformities.*	*Prerachitic type.*	** Mother engaged in married women's labour.*
Before three months . . .	Nil.	Nil.	...
From three to six months . .	1*	Nil.	*1 case.
From six to nine months . .	1	Nil.	...
From six to twelve months . .	7*	2	*4 cases.
From twelve to fifteen months .	2*	1	*2 cases.
From fifteen to eighteen months .	1*	...	*1 case.
From twelve to eighteen months .	2*	...	*2 cases.
Totals . . .	14	3	10

Note.—In addition to the seventeen cases above recorded, troublesome gastro-intestinal symptoms are cross-indexed from the clinical reports in seven cases.

For various reasons indicating that the exciting cause of the rachitic deformity was other than chronic gastro-intestinal disorder, these have been detailed under the following groups:

Fat deficiency with carbohydrate excess . .	1
Prolonged breast-feeding	1
Finance	1
Diathesis	3
Unexplained	1

H. POST-INFECTIVE MALNUTRITION.

14 cases. 2·6 per cent.

(1) Severe deformities	1
(2) Slight deformities	11
(3) Prerachitic—early signs . .	2

Method of feeding.	*Meningitis.*	*Bronchitis. Broncho-pneumonia.*	*Congenital Syphilis. Icterus Neonatorum.*	*Diphtheria. Entero-colitis.*	*Icterus Neonatorum. Enteritis ? Scarlatina.*	*Lymphatic Leukaemia.*
(*a*) Breast-feeding, then fresh milk . .	1	1	3	1	...	...
(*b*) Breast-feeding and 'Glaxo' to eleven months, then fresh milk.	...	2	...	...	...	...
(*c*) Breast-feeding, then Nestlé's sweet milk, then fresh milk.	...	2	...	...	...	...
(*d*) Breast-feeding to five months, then fresh-milk-cream mixture to nine months. After recovery from illness a general diet with adequate fat and fresh milk.	1	...	...	...	...	...
(*e*) Fresh milk, then 'Allenbury No. 1' and 'No. 2' from two months to nine months.	...	1	...	...	1	...
(*f*) Fresh milk, adequate fat, and a good diet later.	...	...	...	...	...	1
Totals	2	6	3	1	1	1

In this group the onset of rickets dates from a period of malnutrition which was the result of severe infection, and the symptoms of rickets appeared either with the cachexia of congenital or acquired disease or during a protracted convalescence.

There has been no indication either in the series collected before the war or in the investigation under review that infective disease is a frequent antecedent to rickets.

Thus:

330 cases of rickets, collected between 1905 and 1914.

(1) Of 219 Riverside (casual labour cases):
  in 183 there had been no previous incidence of infective disease;
  in 36 where rickets had been preceded by an infective fever;
    in 21—the infection was broncho-pneumonia, lobar pneumonia, or acute bronchitis;
    in 8—the infection was measles;
    in 7—the infection was whooping-cough.

(2) Of 111 Outer Ring (suburban cases):
  in 97 there had been no previous incidence of infective disease;
  in 14 where rickets had been preceded by an infective disease;
    in 10—the infection was 'pneumonia' or acute bronchitis;
    in 4—the infection was measles.

In no case was the parent inclined to believe that rickets had been produced by the preceding illness. In the majority of cases—fifty in number—the illness had not been severe and had given rise to little or short-lived anxiety.

The first year of life, which is the special age of incidence for rickets, is a time relatively free from exanthemata compared with the later years of childhood, owing to immunity of parental origin. Nor during the second year of life does the rachitic child appear to be unduly liable to infectious fever as compared with the control child when it is remembered that the families of the former, as a whole, are poorer and their food is generally of worse quality, two factors which predispose to anaemia, malnutrition, and the incidence of disease. During the three years under review there was a severe epidemic of whooping-cough throughout the winter of 1919–20, and a very high incidence of scarlatina and diphtheria throughout 1920 and 1921.

Yet healthy controls and rachitic children appeared to be equally liable to infection.

Moreover the study of the mortality rate during the past 2½ years does not indicate increased severity of infection or marked lowering of resistance among the rachitic children, for there is little difference in percentage mortality.

Thus:

Rickets. 533 cases.

Controls. 420 cases.

Total Deaths. 24.

Rickets. 14. (2·6 per cent.)	
Broncho-pneumonia	3
Measles with broncho-pneumonia	3
Whooping-cough with broncho-pneumonia	1
Diphtheria (tracheotomy)	2
Scarlatina	1
Chronic nephritis with general tuberculosis	1
General tuberculosis	1
Lymphatic leukaemia. Whooping-cough	1
Enteritis	1

Controls. 10. (2·3 per cent.)	
Broncho-pneumonia	4
Acute bronchitis	1
Whooping-cough	2
Enteritis	1
General tuberculosis	1
Tuberculous meningitis	1

Infectious disease, however, undoubtedly delays recovery from rickets even when a good diet is available. There seems to be a retardation of calcium precipitation as well as a cessation of growth and a marked diminution in muscular power.

Thus, a rachitic child of fifteen months who could just walk, after an attack of broncho-pneumonia was unable to walk again until the age of twenty-one months, although receiving a satisfactory diet. Again a rachitic child of twenty months who could just manage to walk up a short flight of stairs, after an attack of broncho-pneumonia, although carefully fed, was unable to walk so strongly again until the age of 25 months. Recovery of muscular power appears to precede growth and satisfactory ossification at the epiphysial lines.

All the cases of rickets in this group were very ill indeed with severe infections, and it seems possible that as a result there was damage to some essential link with the bone-forming cells, whether to bone-marrow, or to tissue-fluids secreted therefrom.

Thus, the only case in this group developing severe deformities was one of lymphatic *leukaemia.* T. C., age $1\frac{11}{12}$ years. No. 391. This boy while under observation for that anaemia developed severe rickets and was admitted to the Evelina Hospital where he remained as in-patient for seven months before dying of whooping-cough. Throughout this period in hospital an excellent diet was provided, including fresh milk, butter, cream, cod liver oil, and occasionally dripping—in suitable proportions. No improvement occurred either in the X-ray appearance of the epiphysial lines or in the general condition of the bones. Perhaps at one period while the child was receiving dry thyroid gland (B.P.) there was slight improvement, but this was only temporary, and the use of 'polyglandin'—a proprietary preparation, was abandoned on account of the diarrhœa which it produced. Weights: 19 lb. at 23 months, 18 lb. 9 oz. at $2\frac{6}{12}$ years.

Lymphatic leukaemia is one of those fatal anaemias in which a cellular revolution has spread to the bone-marrow, and it is possible that the disorganization of the bone-marrow and of the tissue-fluids which form the environment of the bone-forming cells destroys a necessary link which is vital for satisfactory calcium precipitation, in the absence of which link even an adequate diet including cod liver oil is singularly without effect.

A similar case of failure of treatment was that of D.R. No. 70, who was suffering from chronic tubal nephritis. This baby girl developed signs of rickets during the first year of life while taking sweetened condensed milk (indexed fat deficiency with carbohydrate excess). She subsequently developed scarlatina and nephritis, signs of rickets becoming more marked. Albuminuria persisted, and she was admitted to the Evelina Hospital, having failed to make progress with ordinary doses of cod liver oil and a satisfactory diet. She remained in hospital for twenty months until her death. Intensive treatment with cod liver oil, $2\frac{1}{4}$ fluid ounces daily, was practised for ten months, and she also received a diet of about 1000 calories value, including ℥xv of fresh milk and ℥j of dripping daily. Very little growth resulted.

Considerable but irregular calcification was found at the autopsy, the shafts of the tibiae being thicker and stronger, with the deposit of dense bone at the most prominent part of the bowed shafts, and irregular calcification at the epiphysial regions. Chronic tubal nephritis was present, small white granular kidneys and miliary tuberculosis of the lungs, liver and spleen, the latter infection due to generalization of old mesenteric tuberculosis. During the second year of life she had received a war-time dietary with a small quantity of milk—less than half a pint daily. Tuberculosis was not diagnosed during life. Death at the age of $6\frac{6}{12}$ years.

Weights: 17 lb. 12 oz. at $3\frac{6}{12}$ years, 21 lb. 12 oz. at 5 years, 23 lb. 3 oz. at 6 years, 23 lb. 12 oz. at $6\frac{5}{12}$ years.

Heights: 31 in. at $4\frac{6}{12}$ years, $31\frac{1}{4}$ in. at $5\frac{10}{12}$ years, $32\frac{3}{4}$ in. at $6\frac{7}{12}$ years.

Methods of feeding in this group are described under six headings. With two exceptions the diets were of good quality and balance, and of satisfactory caloric value, while great care was taken in the preparation and giving of food.

The following are additional notes of cases in this group:—

V. B. No. 449. A baby boy, premature, eight months. The baby was breast-fed to the age of five months, but the child 'did not thrive from birth', and as the mother's health was not good he was weaned by advice of the Welfare Centre. From five months to nine months of age he was fed on a fresh milk and cream mixture, at the latter age he developed meningitis; he was very ill indeed, and made a slow recovery, subsequently receiving a general diet containing adequate fat and a satisfactory amount of fresh milk until the age of nineteen months. Signs of rickets first appeared at the age of thirteen months. Weight 18 lb. 14 oz. At nineteen months, weight 21 lb. 15 oz. After the age of nineteen months his general condition improved and signs of rickets disappeared, though dentition was much delayed and both rise in weight and increase in height were slow.

H. M. No. 482. Baby boy. Breast-feeding was employed to the age of one month, when secretion failed, and the child was then fed with 'Glaxo' and 'Virol' to the age of twelve months, successfully, under direction of a Welfare Centre. He was then admitted to hospital for severe broncho-pneumonia—four weeks high fever—and a protracted convalescence subsequently. From thirteen months to seventeen months he received a satisfactory diet including ℥x fresh milk and butter; his appetite remained poor. Early signs of rickets were diagnosed at the age of sixteen months with marked hypotonia of muscles. He was able to walk with help at the age of nine months, but after the illness he did not walk again until the age of eighteen months; he made a good recovery later, taking ℥xx minimum fresh milk and ʒvj cod liver oil daily. Weight 31 lb. 8 oz. at $2\frac{10}{12}$ years. Prerachitic early signs only.

D. C. and S. C., twins. Female and male. Icterus neonatorum, congenital syphilis, strong positive Wassermann from blood of the umbilical cord. Treated with six intramuscular injections of galyl and by mercury in alternate months. Breast-feeding employed for one month and then fresh milk by bottle. No vomiting, but intermittent diarrhoea. At the age of ten months both children showed early signs of rickets. D. C. developed signs of scurvy—successfully treated with lemon juice. Slow progress subsequently. Careful dieting.

D. C. at birth: weight, 4 lb. 8 oz., length, 17 in.; at eleven months, 12 lb. 8 oz., length 26 in.

S. C. at birth: weight, 6 lb. 0 oz., length, 19 in.; at eleven months, 12 lb. 8 oz., length, 25½ in.

These twins received most careful nursing in Lambeth Infirmary. They were contact cases with scarlatina at the age of eight months, and it is possible that they were infected then.

E. P. baby boy, illegitimate child of an anaemic mother. Icterus neonatorum. Negative Wassermann.

Breast-feeding only attempted for fourteen days as the child lost one pound in weight. Enteritis with 'thrush'. Carefully fed by bottle with citrated whole milk for two months, loss in weight continued, and at the age of two months the child had lost two pounds as compared with birth weight. At the age of ten weeks fed by bottle with 'Allenbury No. 1', at three months 'Allenbury No. 2'; slow progress. Regained birth weight at the age of five months. At six months staphylococcal infection, boils and enlarged glands. At eight months, contact with scarlatina. Developed fever, enlarged tonsils, probably infected. At nine months developed scurvy. Diet changed from 'Allenbury No. 2' to whole citrated milk and lemon juice. At 9½ months early signs, X-ray, rickets at the epiphysial lines. Subsequent improvement, slow progress. Received most careful nursing in Lambeth Infirmary. Weight at birth, 7 lb. 0 oz.; at one month, 6 lb. 1 oz.; at two months, 5 lb. 2 oz.; at four months, 5 lb. 12 oz.; at five months, 7 lb. 4 oz.; at six months, 8 lb. 8 oz.; at eight months, 11 lb. 8 oz.; at nine months 11 lb. 8 oz.; at twelve months, 11 lb. 10 oz.

Apart from the fourteen cases in this group, infective disease has been cross-indexed in five other cases as exerting a contributory though not a chief influence in the onset of rickets.

These cases have been indexed under the following headings:—

Groups.	*Infection.*	
Breast-feeding	Measles and whooping-cough	2 cases.
Finance	Diphtheria	1 case.
Diathesis	Icterus neonatorum, Enteritis	1 case.
Carbohydrate excess	Icterus neonatorum	1 case.

I. PREMATURITY.

3 cases. 0·5 per cent.

Three cases of rickets with slight deformity have been placed in a group by themselves. They were born prematurely and were on that account small, ill-nourished babies, who made slow progress from birth in spite of a satisfactory diet and excellent mothercraft.

It will be noticed that the history obtained suggests that antenatal conditions were responsible both for premature delivery and for the subsequent onset of rachitic deformities, but as the reports of the health of the mothers could not be substantiated by any one who had knowledge of them during their respective pregnancies it was thought better to group them together under the heading of 'Prematurity'.

The following are the notes of the three cases.

A. M. No. 50. A baby boy, delivery at 7½ months. The mother's statement is to the effect that she was in poor health during her pregnancy, May 1916 to January 1917; she lost one of her children and three other near relatives, and became very depressed and nervous on this account, and also by reason of anxiety at the time of the London air raids. The baby A. M. was breast-fed entirely to the age of nine months, when he was weaned as advised by the Infant Welfare Centre. He was then fed with a war-time dietary which included one pint of fresh milk daily, the yolk of an egg, raw beef juice, and rusks. The child was well cared for, and in spite of the war this diet was maintained until the age of $2\frac{2}{12}$ years.

At birth the bones were very soft and there were congenital foetal curves of the tibiae. The child grew very slowly, and there were definite signs of rickets before the age of eight months.

The first tooth irrupted at the age of ten months, but there were still only 16 teeth at the age of $2\frac{9}{12}$ years, at which age the anterior fontanelle was still open.

The lower radial epiphyses were enlarged at the age of eight months; deformities of the tibiae appeared at the age of twenty-two months, when he was first able to stand. He could not sit up at all until he was twelve months of age. After the age of twenty-two months he became weaker, and did not start walking until the age of $2\frac{8}{12}$ years.

A general diet was given from the age of $2\frac{2}{12}$ years.

He has spent a great deal of time in the open air, sitting in the garden for the greater part of the day whenever weather was fine enough.

The abdomen was unduly distended owing to excess gas formation, and this was a prominent feature from an early age until the age of 3 years when his weight was 25 lb. 12 oz. and his height was 32 in.

An adequate and satisfactory diet was maintained, and he made slow progress up to the age of $4\frac{2}{12}$ years when the legs were stronger and the bones were straighter, though he was somewhat flat-footed. The abdomen at this age was still unduly distended, there was still some tendency to excess gas formation, with other indications of dyspepsia, occasional anorexia, flushed face, bulky motions.

Little cod liver oil was given, but reliance was placed upon the presence in the diet of one pint of milk and dripping daily, an occasional egg and the addition of butter, ¼ pound weekly.

At $4\frac{2}{12}$ years. Weight, 31 lb. 0 oz. (normal for 3 years). Height, 35¼ in.; stem height, 21 in. (normal for 3 years). Head circumference, 20¾ in. (normal for 10 years).

There is no family history of rickets on either the father's or mother's sides.

G. J. No. 463. A baby girl, delivery at eight months. The mother suffers from rheumatic heart disease. For the first four months of her pregnancy she was in hospital and returned there for an instrumental delivery.

The baby was breast-fed for one month only, and then secretion failed. From one month to two months of age the child was fed upon 'Cow and Gate' dried milk, but this was not taken well; there was frequent vomiting, and at the age of two months a change was made to fresh milk and water which was given in suitable proportions, successfully. Butter and dripping with a little bread were introduced into the diet at the age of nine months. No condensed sweetened milk was employed at any time.

At the age of ten months there were definite signs of rickets and congenital foetal bowing of the tibiae had become more marked, as the child could stand with help at the age of nine months. At the age of ten months the weight was 14 lb. 0 oz., and the height 25 in.

The case subsequently did well with a diet containing ℥xxx fresh milk and ℥ss cod liver oil daily.

F. M. No. 339. A baby boy, delivery at seven months. The mother suffered from profuse haemorrhages from the second to the fifth month of pregnancy. She became very weak and anaemic. Delivery took place at just over seventh month date. The boy was bottle-fed with fresh milk to the age of fourteen months, practically no other food was given, and no breast-milk was available.

The child made slow progress from birth, being a very small baby at the time of delivery. At the age of nine months early signs of rickets were diagnosed and congenital foetal curves of the tibiae became more marked with enlargement of epiphyses. He remained under supervision of a Welfare Centre from the age of nine months, and an adequate diet without war-time shortages or sugar excess was provided until the age of $2\frac{10}{12}$ years. He made satisfactory progress later, still receiving a great deal of care and a satisfactory diet, subsequently, at the age of 5 years, his weight was 42 lb. 0 oz. and his height 41½ in.

Two younger children, one of whom was premature at eight months, were afterwards under observation as healthy controls. They were hand fed with fresh cow's milk and later with 'Glaxo', developing no signs of rickets.

In addition to the above three 'premature' babies, who developed rickets and have been described in a separate group, 'prematurity' occurs in twenty instances among the series of 533 cases of rickets and 428 healthy controls.

Of these twenty, seven were control cases.

The remainder have been classified under the following headings:

Groups—

Fat deficiency with carbohydrate excess	1 case.
Breast-feeding	5 cases.
Finance	2 cases.
Diathesis	2 cases.
Post-infective malnutrition	2 cases.
Carbohydrate excess	1 case.

V. DELAYED OSSIFICATION

8 cases.

Cases are occasionally found which are distinguished by the fact that ossification processes are much delayed during the first two years of life. Dentition is delayed in general, the membrane of the anterior fontanelle ossifies at a much later date than is usual, and the shafts of the long bones remain very thin for a long time owing to inactivity of the periosteum. During the first and second years of life even an adequate diet of suitable fat-carbohydrate balance does not appear to hasten ossification, though rachitic deformities do not develop if the diet be satisfactory. The vertex of the head may be flattened and the skull of so-called rachitic type, but the long bones remain straight without enlargement of epiphyses, the bones being thin and small.

Severe examples of such a condition are indistinguishable from osteogenesis imperfecta, when the patient, subject to repeated fractures of the long bones, as a result of slight injuries, grows slowly even with a generous dietary including a more than full ration of calcium and animal-fat. One such case is included in this group. The child was the youngest of a family of four (I. K. No. 257), of whom the third had developed rachitic deformities previously. I. K. was breast-fed alone to the age of two months; breast-feeding, with additional feeds of fresh milk was continued to the age of 4 months, when the child was weaned and thereafter fed upon an adequate diet, always including fresh milk and lime-water. From an early date cod liver oil ℥ss daily was given. Her height, at the age of $4\frac{7}{12}$ years, was $32\frac{1}{2}$ in., stem height $19\frac{1}{2}$ in., and at $5\frac{11}{12}$ years the height was only 33 in., the stem height unchanged—$19\frac{1}{2}$ in. No other similar cases were known either in the family or among relatives.

A baby—the fifth child in the family—was subsequently born and remained under observation as a healthy control fed by breast, with additional feeds of fresh cow's milk (q. v.). At the age of seven months this child weighed 13 lb., the first tooth had irrupted, and the fontanelle was beginning to harden.

The radiograph of the epiphysial region in a case of delayed ossification shows a broadening of the epiphysial line without the crater appearances which are so typical of rickets. Such indications of delay in ossification may also be seen as a result of prolonged convalescence from infection, and two of the eight cases here recorded were associated with chronic tuberculosis and follicular ileo-colitis.

The following are additional notes of cases in this group:—

E. B. No. 268. Baby boy. Full-time delivery. The mother had a good time during her pregnancy except that she was very frightened by many air-raids—June 1916 to March 1917—and especially by the Silvertown explosion about half a mile away in January 1917 when she was seven months pregnant. There was no food shortage. The boy was breast-fed alone until the age of ten months, no other food was given. The mother was well able to feed her child, and she took a pint of fresh milk daily, herself, while doing so. From ten months to fourteen months of age breast-feeding was continued, with additional feeds of fresh milk. He was weaned at fourteen months to 'slop foods' 'as he did not seem able to eat and masticate solid food'. The mother continued to give the boy one pint of milk daily up to the age of two years, and after that age half-a-pint was still continued.

No condensed or dried milk had ever been used. From the age of eighteen months dripping was included in the diet, and after the age of two years three ounces of butter weekly was also given. He is not very fond of sugar, and he will always drink his milk without sugar. The family ration of sugar, parents and child, was $1\frac{1}{2}$ lb. weekly.

Dentition was delayed. No teeth irrupted until the age of thirteen months. Subsequently he had 18 teeth at $2\frac{10}{12}$ years.

The anterior fontanelle closed at the age of $2\frac{10}{12}$ years, when his weight was 28 lb. Height, 35 in., normal at three years. Height, 40 in. at $4\frac{1}{2}$ years.

No deformities ever appeared. No enlargement of epiphyses.

Skiagram—broad epiphysial lines.

Weight, 32 lb. 10 oz. at $3\frac{11}{12}$ years.

Two of the mother's sisters suffered from rickets as children, and bowing of the tibiae is still obvious. The mother herself never showed signs of rachitic trouble.

W. P. No. 261. Baby boy. Breast-feeding was only possible for ten days when secretion failed. From the age of ten days to the age of nine months bottle-feeding with Nestlé's sweet milk was employed. At nine months his weight was 14 lb. Height, $27\frac{1}{2}$ in. He was subsequently fed with fresh milk and cod liver oil and a satisfactory diet, including dripping. Dentition was delayed; there were 6 teeth at eighteen months and 14 teeth at two years of age. The fontanelle closed at two years of age.

He had broncho-pneumonia—severe—at four months and diphtheria at sixteen months of age. No signs of rickets. Height, $29\frac{1}{2}$ in. when two years old. Subsequently he made progress slowly.

Another child—a girl—a year older than this boy, showed similar delayed dentition, delayed closure of the fontanelle, and a subnormal height, $30\frac{1}{2}$ in. at $1\frac{10}{12}$ years. Satisfactory dieting. No signs of rickets.

Similarly in three other cases the closure of the fontanelle was delayed, as was also dentition, the heights were subnormal, the bones small without deformity. No signs of rickets.

H. W. No. 443. Baby boy. Fontanelle closed at $2\frac{6}{12}$ years. Weight, 21 lb. 11 oz. at twenty-three months. Height, 33 in. at $2\frac{10}{12}$ years. Breast-feeding to the age of ten months, and a satisfactory diet thereafter. Diphtheria-tracheotomy at ten months of age. Made a delayed recovery during three months.

M. W. No. 384. Baby girl. Fontanelle closed at $2\frac{6}{12}$ years. Breast-feeding alone to the age of six months, subsequently continued with additional feeds of Nestlé's sweet milk to the age of nine months, when the child was weaned and was fed thereafter upon 'Nestlé's sweet milk and the run of the table'. Occasionally butter, bacon fat, and about half a pint of fresh milk. The mother says (voluntary statement) that during lactation she herself was 'never short of food' and that she has 'a good husband.' M. W.'s weight at twenty-one months was 16 lb. Height at $2\frac{4}{12}$ years was $29\frac{1}{2}$ in. No signs of rickets developed.

D. W. No. 280. Baby boy. 'Glaxo'-fed by bottle. No breast-feeding. Fontanelle closed at $2\frac{3}{12}$ years. Dentition delayed. 11 teeth at $2\frac{1}{12}$ years, 16 teeth at $2\frac{5}{12}$ years, 20 teeth at $3\frac{2}{12}$ years. Weight, 23 lb. 8 oz. at $2\frac{5}{12}$ years, 25 lb. 10 oz. at $2\frac{8}{12}$ years. Height, $33\frac{1}{2}$ in. at $3\frac{\text{[illegible]}}{12}$ years. No signs of rickets developed.

All such cases are potential cases of rickets, and no liberties can be taken with them in the matter of diet. Carelessness in the matter of maintaining a satisfactory fat-carbohydrate balance is followed, rapidly, by severe deformity.

VI. CONCLUSIONS

A. General Considerations.

In undertaking an investigation of this character dealing with a disorder which is to be met with in very different degrees of severity, under social conditions which differ so widely, a caution must be given as to the erroneous deductions which might be drawn from working in too narrow a field. Visibility must be good. If, for example, at the present time in London cases of rickets were to be looked for only at the Welfare Centres, there would be no indication of fat deficiency as a causative factor, for, without exception in my experience, the Welfare Centres in London are working along the lines which ensure an adequate supply of milk-fat to the nursling and weanling. Again, if the out-patient department of a large hospital in a district populated by casual-labour workpeople is the field of investigation, financial problems are constant, and health, food, and housing are all subject to the fluctuations of wages, which, even when at the maximum provided by a full week of work are barely sufficient to support a family of children not above school age. And lastly, if rickets is only studied in suburban districts where wages are always regular and living is never precarious, the diet of the child affected will often be found to be a liberal one and to contain expensive items of food.

As a result of the fact that rickets occurs under circumstances which differ so greatly, there has been sometimes a tendency to attach undue importance to the occasional incidence of the disorder under conditions which are quite exceptional and which are not followed by severe symptoms, rather than to lay stress as a matter of national importance upon:—

(1) The conditions under which the great majority of rickets cases occur.

(2) The conditions which are associated with severe symptoms, that is to say, with marked deformity and cessation of growth.

For about five years before the war—i.e. 1910 to 1914—the incidence of rickets was diminishing; not only were the cases appearing less frequently in the out-patient departments, but severe neglected cases attending for the first time at hospital were less common.

This five-year period in London corresponds with two important new institutions in public health work:—

(*a*) Maternity and Infant Welfare Centres were started as centres of social work, staffed and organized by voluntary workers, who began to make their influence felt in a type of home where the parents had 'no faith in hospitals', and incidentally no money for the 'pay doctor'.

(*b*) The school nurse—working in conjunction with the newly appointed medical officers of the public elementary schools—was quietly producing a change in the general cleanliness of the home, for though her work was actually concerned with children of the school age, 4 years to 14 years, indirectly her influence was much wider, and the marked increase in cleanliness which first appeared in those children for whom she was responsible showed itself also in the persons of the parents and of their babies, in the condition of the bedding and clothing and of the rooms of the home.

My knowledge of the working-class homes in Southwark and Bermondsey dates from the year 1901, and during those last twenty-one years the improvement in general social conditions is especially to be dated for the above five-year period. In street after street the housing conditions are unaltered, the rooms are the same; certain districts, such as the Tabard Street area, have, it is true, disappeared, but such building changes affect a relatively small area, while the improvement is widespread and definite.

On my return to London early in 1919 cases of rickets appeared to be more frequent than in the year 1913–14, and this rise in incidence was generally recognized by many who were engaged in various forms of social work in the South London districts.

During the past two years—April 1919 to April 1921—there has been a rapid diminution in the number of rickets cases, and severe cases of deformity are found rarely, indeed only after considerable search in some of the more inaccessible small streets and poor tenements where rent and wages tend to be lowest. Rickets is not only becoming much less frequent, but such incipient cases of rickets as occur are almost invariably checked in the prerachitic stages by coming into touch with a Welfare Centre. The evidence obtained by this investigation suggests plainly that in ten years' time, so far as London is concerned, rickets will be relatively uncommon.

No more conclusive proof can be given of the valuable work which the Welfare Centres are doing than these records, which indicate that where in a family the earlier children have been rickety, the later children, who alone have been under supervision of a Welfare Centre and fed under the assistance of that agency, are free from rickets. This successful control has been noticed repeatedly.

Owing to the prevalence of casual labour in the riverside districts of London, where the majority of cases have been found, *financial troubles are of primary importance, and under these conditions the great majority of cases occur.* More often than not the diet of the children has been chosen for its cheapness, because it is easily stored, not liable to deteriorate with storage and therefore not productive of waste. This is the main reason that sweetened condensed milk is so commonly used in a family of this class, and the brand of milk used, whether 'machine skimmed' or 'full cream' depends upon the weekly income available for the food of the table after the obligatory charges of rent, insurance premiums, 'club' subscriptions, gas and other fuel, have been met.

For a similar reason the quality of the principal foodstuffs changes and the more expensive fats are deleted, their place in the diet-sheet being taken by the less expensive carbohydrate items, especially potato and bread.

Any measures which may be taken to diminish casual labour and to secure a regular wage, or—as the Infant Welfare Centres are doing—to remedy the lack of balance in diet which is produced by an income necessitating cheap food for children during their first two years of life, will rapidly bring about a very marked decrease of rickets in an industrial area, while cases influenced little by such measures, but relatively a small percentage of the total number, will still arise as a sequel of infective disease, of prematurity, or by reason of an inherited disability to make bone which is peculiar to some families.

B. DETAILED CONCLUSIONS.

1. If a wide survey is taken of the conditions which predispose to the occurrence of rachitic deformities in children under the age of two years, the continual use of an unbalanced diet characterized by deficiency of fat and excess of carbohydrate will be found to have antedated the appearance of symptoms in about 45 per cent. of the total cases (*vide* Table X, pp. 37, 41).

2. Rickets occurs more frequently, and is more severe in type, in poor-class industrial districts, where the bulk of the population choose a cheap diet which can be stored without deterioration, and which is therefore not productive of waste. For this reason sweetened condensed milks of various brands containing 40 to 45

per cent. of cane sugar, added for preserving purposes, figure more often than any other milk food for infants (*vide* p. 41).

3. Severe cases arise more frequently when fat deficiency is associated with cane sugar in excess than with starch in excess. A fat-sugar ratio of 1 : 5 if continued during a period of active growth produces sooner or later signs of rickets (*vide* pp. 42, 43).

4. In some cases when tolerance for fat is low during the early months of infant life, the use of a sweetened condensed milk may be successful as a temporary measure, but the continuation of such a diet when growth of bone-forming cells becomes more rapid, and especially after the seventh month, is a frequent cause of severe rickets unless additional fat such as dripping, butter, cream, suet, or fresh milk, is provided *pari passu* with the rise of fat tolerance (*vide* pp. 28, 29, 30).

5. In 16 per cent. of the cases investigated signs of rickets appeared during breast feeding. In many of these instances the mother's health was indifferent or she was suffering from disease. In other cases her food was inadequate and her weight was falling in marked degree during lactation, the secretion of breast-milk being maintained. In a considerable number of cases prolonged lactation, 12 to 24 months, was practised for no other reason than to save money by avoiding the purchase of milk (*vide* pp. 45, 46).

6. Rickets is a feature of industrial life where the disabilities of casual labour are prevalent—16 per cent. of the cases were grouped under this heading, briefly headed 'Finance'. The group has purposely not been described under the designation 'Poverty', for under starvation conditions growth ceases and rachitic changes do not occur. In all such families as are described under the heading of 'Finance' the diet is variable and of border-line adequacy. One week it is satisfactory, and the child receives adequate milk, the next fortnight it is most unsatisfactory, and the child is given the cheapest brand of skimmed condensed milk in the market, and the cheapest or damaged, unsaleable forms of carbohydrate food, including especially potato, bread, or 'broken biscuit' (*vide* pp. 50, 51).

It was noticed before the war, during the study of 330 cases, and also during the first year of this inquiry, that if at the age of ten or twelve months the diet of a child contains not more than ten fluid ounces of fresh milk and no other fat except margarine, then rachitic changes usually ensue. More recently there have been better brands of margarine or margarine-butter mixtures on the market, which seem to provide a satisfactory fat for the young child (*vide* pp. 43, 52).

In such a home of this class dripping provides the preventive measure *qua* rickets, and if the child is healthy and old enough to digest a form of fat which is solid at the ordinary air temperature, it is probable that no immediate disabilities will be observed even with a diet containing only condensed sweetened milk. The remote disabilities are obvious when such a child in after years at the age of 14 is compared with the type of boy or girl who has been fed on fresh food and fresh milk.

7. Some families are more likely to develop rickets than others, and with all such children no liberties can be taken in the matter of dietary. With some there is a hereditary disability to make bone which shows itself more especially during the first two years of life, when growth of bone is more rapid, and signs of rickets may appear even when a well-balanced diet has been employed, while, if the diet contains sugar or starch excess with fat deficiency, very severe deformities will develop. A badly-balanced diet intensifies the defects resulting from delay of ossification.

Under the heading of ‘ Diathesis ’, thirty-nine cases (7·3 per cent.) are grouped. Either one or both parents of these children suffered so severely from rickets, when infants, that deformities and other rachitic stigmata are very obvious in adult life at the present time.

This group is probably much larger than would appear from the numbers collected and those cross-indexed under other headings. No attempt was made to investigate collateral families with rickets who were frequently referred to by the parents of rachitic children, or to examine grandparents who were cited as exhibiting rachitic deformities (*vide* p. 59).

8. *Carbohydrate excess.* This group, which includes cases of ‘ overfeeding ’, only includes 4·5 per cent. of the total, twenty-four cases in all; for the district of London in which the vast majority of cases have been found and where their homes are situated, is distinguished by lack of money rather than by excess of food. Such cases are more commonly found attending Welfare Centres in localities where wages are regular and in homes where patent foods of expensive type and sugar are used freely.

The interesting point about such cases of rickets is that, given a sufficiency of fat, excess of carbohydrate tends to produce a different type of case: the deformities are rarely severe; the bony changes rarely pass beyond an early stage; the child is of pale complexion, but not anaemic; the muscles are exceedingly flabby; there is usually no excess of subcutaneous fat, which is, however, of watery, flabby type; the belly is enormously distended with excess of gas in the small intestine; the weight is usually one to three pounds subnormal (at 15 months), sometimes the child’s weight may be normal or above normal (*vide* p. 57).

9. Chronic gastro-intestinal disturbance and infective disease are occasionally followed by a state of malnutrition during which signs of rickets and rachitic deformities may develop. Chronic follicular ileo-colitis, chronic parenchymatous nephritis and leukaemia have provided the only examples of failure to react to treatment by correction of the adverse fat-carbohydrate balance and by intensive treatment with large doses of a reliable Norwegian brand of cod liver oil (*vide* pp. 67, 70).

10. Non-rachitic cases. There were 436 cases of healthy children who were examined and supervised at hospitals or at Infant Welfare Centres, and routine visits were paid to their homes following the same method of investigation as was practised for the cases of rickets.

Among these 436 cases:—

Of 245 non-rachitics who were from the first regarded as healthy children coming under observation mostly between the ages of six months and twelve months—three developed rickets.

Thirty-five different methods of feeding are described (*vide* p. 24).

Of 191 non-rachitics who were born in families where one or more children were already under observation for rickets—five developed rickets.

Eleven different methods of feeding are described (*vide* p. 31).

The success obtained in the prevention of rickets among the youngest children of these rachitic families is undoubtedly due to the supervision exercised by the Infant Welfare Centres and to the powers obtained by the Centres for the provision of suitable milk for necessitous nursing mothers and hand-fed infants.

11. There has been no evidence from this investigation in London that bad housing, overcrowding, and deficient air-space are responsible for the onset of rickets. The control cases and the rachitic cases are living side by side under similar conditions. Such evils where present are a cause of anaemia and ill health for both groups of cases (*vide* Tables III, IV, IV A, V, V A).

12. Singularly few evidences of overcrowding, lack of cleanliness, and want of ventilation have been observed in the homes which have been under observation. Surprise visits have been frequent. An immense improvement in the matter of cleanliness has been observed when the conditions are compared with those prevailing twenty-one years ago (*vide* pp. 12, 13 *et seq.*)

13. 'Delayed ossification' is to be distinguished from rickets. Cases of delayed ossification are always potential cases of rickets. No liberties can ever be taken with such cases in the matter of an ill-balanced dietary, the sanction of which exposes the child to the possibility of severe deformities. The delay may be regarded as a peculiarity of family, personal to the child, the deformities which follow as a result of the formation of osteoid rachitic cells being an acquired disability due to ignorant or careless dieting (*vide* p. 76).

APPENDIX 1. METHOD OF FEEDING WITH UNDILUTED CITRATED MILK (*v. Guy's Hosp. Gazette*, 1914)

These are the quantities of milk which are used at Out-Patients; the figures which are given may be taken as a *good working guide for the great majority of cases.* In some instances, if the child is ill or some form of dyspepsia is already present, slightly smaller quantities may be indicated for a week or two, but a return will very soon be made to standard totals:—

a. Baby, seven days old, weight 8 lb.
  Feeds 9 per diem, 2 oz. each.
  Total whole milk, 18 oz. = 360 calories.
  (1 oz. milk, 3·5 per cent. fat = 20 calories),
  or 45 calories per pound.

b. Baby, fourteen days old, weight 8 lb. to 8½ lb.
  Feeds as above,
  or 45 calories per pound,

c. Baby, one month old, weight 9 lb.
Feeds 9 per diem, 2½ oz. each.
Total whole milk, 22½ oz. = 450 calories,
or 50 calories per pound.

d. Baby, two months old, weight 10 lb.
Feeds 8 per diem, 3 oz. each.
Total whole milk, 24 oz. = 480 calories.
In addition—
Malt extract one teaspoonful dissolved in half an ounce of warm milk (not given with milk feeds) = 30 calories, containing 90 grains maltose.
Total, 510 calories,
or 51 calories per pound.

e. Baby, three months old, weight 11 lb.
Feeds 8 per diem, 3½ oz. each.
Total milk, 28 oz. = 560 calories.
Malt extract as above = 30 calories.
Total, 590 calories,
or 53 calories per pound.

f. Baby, four months old, weight 12 lb.
Feeds 7 per diem, 4 oz. each.
Total milk, 28 oz. = 560 calories.
Malt extract, one and a half teaspoonfulls in half an ounce of warm milk (containing 135 grains maltose) = 40 calories.
Total, 600 calories,
or 50 calories per pound.

g. Baby, six months old, weight 14½ lb.
Feeds 7 per diem, 5 oz. each.
Total milk, 35 oz. = 700 calories.
Malt extract as above, 40 calories.
Total, 740 calories,
or 50 calories per pound.

h. Baby, eight months old, weight 17 lb.
Feeds 6 per diem, 6 oz. each.
Total milk, 36 oz. = 720 calories.
Malt extract, two teaspoonfuls in three-quarters of an ounce of warm milk = 55 calories (containing 180 grains maltose).
Total, 775 calories,
or 45 calories per pound.

i. Baby, ten months old, weight 19 lb.
Feeds 5 per diem, 7 oz. each.
Total milk, 35 oz. = 700 calories.
Malt extract, three teaspoonfuls in one ounce of warm milk = 80 calories (containing 270 grains maltose).
Total, 780 calories,
or 41 calories per pound.

In every case these whole-milk feeds are citrated. A very limited number of cases will be found where the undiluted milk can be taken without citration, but when dealing with hundreds of cases, the number that can be so fed will be found to be small, and it is a wiser plan always to citrate the feed, seeing that no harm results from the practice, and there is no means of telling without trial which are the babies of Spartan constitution for whom such non-citrated milk has no terrors.

Extra carbohydrate in the form of malt extract is given as a general rule from the age of two months onwards. In some cases it may be tolerated when the baby is younger and smaller; in others, there is intolerance for maltose or carbohydrate additions in any form throughout the whole of the first year, though it may be said at once that this is quite uncommon. The malt is never added to the regular milk feeds, but the total quantity ordered per diem is dissolved in a little warm milk, and given by spoon in two or three portions between the bottle-feeding times. The reason for this arrangement is quite obvious. In the event of any gastro-intestinal disturbance, accompanied by vomiting or diarrhœa, the extra carbohydrate can at once be eliminated from the dietary without altering the taste or composition of the main milk feeds, which remain relatively low in carbohydrate percentage, and high in proteid. Everybody knows how much trouble is experienced when a baby is ill, quite apart from the illness itself, in connexion with a change in dietary, and a change is very often imperative if feeding has been carried on with a cream and carbohydrate mixture, or with a patent food.

The child very often refuses nourishment simply on account of a change in taste, and much ground is lost before regular feeding can be established. Experience has shown that at such danger times in the first year of life whole-milk feeding is invaluable, providing a small bulk of feed with a high caloric value, and, by means of citration, allowing a relatively high percentage of proteid without signs of indigestion.

A word may be useful as to the amount of citrate salt required. I work at Out-Patients with a solution, and a teaspoonful of this containing the necessary amount of sodium citrate in a drachm of distilled water is added to each feed. Two grains of sodium citrate are used for each ounce of milk until the feed is a four-ounce one, when eight grains are employed. For feeds larger than four ounces that quantity of citrate is often sufficient; if more citrate is required on account of indigestion, I use equal quantities of sodium and potassium citrate so as to prevent the possibility of sodium-retention. Thus, for five- or six-ounce feeds, five grains of each salt in a teaspoonful of distilled water will be added to each bottle. Those quantities never need be exceeded. Sometimes if diuresis is free, the amount of potassium salt may be reduced, but that matter is easily adjusted. There are a certain number of children who manage whole milk quite well with the addition of only one grain or one and a half grains of sodium citrate to each ounce of milk, but experience has shown that it is wiser in the great majority of cases to employ the larger quantity, that is, two grains to the ounce, when the feed is small and the child is feeble, reducing the percentage of citrate as the feeds become larger than four ounces.

The age at which it is possible to use whole milk without citration varies very much. Sometimes at the age of ten months no citrate is required, and at other times it is eighteen months. Even when the child is much older the mother occasionally returns to obtain the prescription because she finds that milk is tolerated so much better, and is taken more readily when it is modified in the above-mentioned way. Similar intolerance for milk, when not citrated, is also observed at times in adult life.

APPENDIX 2. DELAYED OSSIFICATION

Twins fed with undiluted citrated milk. No signs of rickets developed.

4. T. G. and H. G., twins, delivery at 7½ months. No breast-feeding was possible. For the first three weeks a milk-water-lactose mixture was given, and then a patent food was substituted for the lactose, the latter mixture being continued for three weeks. Practically no progress was made. The children were sent to hospital at the age of six weeks. The following weighings were taken:—

	Thomas.	Henry.
At six weeks	4 lb. 7 oz.	4 lb. 0 oz.
At nine weeks	5 lb. 5 oz.	4 lb. 11 oz.
At three months	6 lb. 8 oz.	6 lb. 0 oz.
At four months	8 lb. 0 oz.	7 lb. 12 oz.
At five months	9 lb. 0 oz.	9 lb. 0 oz.
At six months	8 lb. 15 oz.	9 lb. 7 oz.
At seven months	10 lb. 5 oz.	10 lb. 8 oz.
At eight months	11 lb. 2 oz.	10 lb. 6 oz.
At nine months	11 lb. 8 oz.	11 lb. 14 oz.
At eleven months	12 lb. 7 oz.	12 lb. 10 oz.
At twelve months	13 lb. 6 oz.	13 lb. 5 oz.
At thirteen months	14 lb. 0 oz.	14 lb. 0 oz.
At eighteen months	18 lb. 9 oz.	18 lb. 0 oz.
At twenty-two months	20 lb. 8 oz.	20 lb. 0 oz.

Subsequent notes. At the age of $7\frac{10}{12}$ years. Both twins were brought to hospital for inspection. They were both of them of subnormal height and weight for age, but no signs of rickets had developed. One pint of fresh milk was maintained in the diet for each boy except for a short period during the war when only half a pint for each could be obtained.

T. G. age, $7\frac{10}{12}$ years. Height, 44 in. Stem, $24\frac{1}{2}$ in. Weight, 39 lbs. 4 oz. Age, $8\frac{10}{12}$ years. Height, $45\frac{1}{2}$ in. Stem, $24\frac{1}{2}$ in. Weight, 42 lb. 8 oz. T. G.'s anterior fontanelle closed at $2\frac{4}{12}$ years. 20 teeth, dentition completed at $2\frac{8}{12}$ years.

H. G., age, $7\frac{10}{12}$ years. Height, $43\frac{1}{8}$ in. Stem, $23\frac{3}{4}$ in. Weight, 38 lb. Age, $8\frac{10}{12}$ years. Height, $44\frac{3}{4}$ in. Stem, 24 in. Weight, 41 lb. 12 oz. H. G.'s anterior fontanelle closed at $2\frac{3}{12}$ years. 20 teeth, dentition completed at $2\frac{8}{12}$ years.

APPENDIX 3. SHORT SUMMARY OF 330 CASES OF RICKETS COLLECTED BEFORE THE WAR BETWEEN THE YEARS 1905 & 1915

These were divided into two groups:—

A. 219 cases, living in homes in the riverside districts where casual labour and unemployment are frequent conditions of industrial life.

B. 111 cases, living in homes in suburban districts where wages are regular and adequate, the surroundings of the home healthy, every house being provided with garden space.

A. 219 riverside cases. Of these,

In 110 cases there was practically no breast-feeding at all.

In 25 cases breast-feeding was employed for twelve months or over. Namely:—

In 9 cases for twelve months.
In 3 cases for thirteen months.
In 7 cases for fourteen to sixteen months.
In 4 cases for seventeen months.
In 2 cases for 18 months.

Of these, in 14 cases very little other food was given, in 11 cases 'extras' were given in the form of the food of the family, including potato, gravy, bread, margarine, golden syrup, groats with various brands of sweetened condensed milk. No fresh milk was ever used.

In 84 cases breast-feeding was employed for periods of less than twelve months. Namely:—

In 30 cases for six weeks or less.
In 28 cases for six weeks to three months.
In 10 cases for three to five months.
In 5 cases for six months. In 5 cases for six to nine months.
In 6 cases for nine to eleven months.

B. 111 'outer ring' (i.e. suburban) cases. Of these,

In 53 cases there was practically no breast-feeding at all.

In 20 cases breast-feeding was employed for twelve months or over. Namely:—

In 5 cases for twelve months.
In 5 cases for thirteen months.
In 8 cases for fourteen to sixteen months.
In 2 cases for seventeen months.

Of these in 3 cases very little other food was given; in 17 cases extras were given in the form of patent malted starch or starch foods, fresh milk, and the food of the family table, including especially milk puddings (fresh milk), gravy and potato, vegetables, bread and milk, and sugar.

In 38 cases breast-feeding was employed for periods of less than twelve months. Namely:—

In 18 cases for six weeks or less.
In 7 cases it was only given for three or four months.
In 6 cases it was given for five months.
In 3 cases it was given for six months.
In 1 case it was given for seven months.
In 3 cases it was given for eight to eleven months.

Hand-feeding. The high percentage of cases in which no breast-feeding at all was employed, or employed for only short periods, is an indication of the important bearing which hand-feeding has upon the onset of rickets. The difference in type of milk food employed in A, the poor industrial district, and in B, a neighbourhood inhabited by families whose wage-earners are in regular employment, is shown by the analysis below:—

A. Riverside cases. Total 205 cases.

In 123 cases the child was fed upon a sweetened condensed milk, either from birth or as a supplemental feed with breast-milk, or after weaning, prior to the onset of rickets.

In 61 cases diluted fresh milk was given by bottle under similar circumstances prior to the onset of rickets. Of these
  In 52 cases sugar was added.
  In 3 cases cream and sugar were added.
  In 6 cases there were no additions.

In 10 cases the information was unreliable—the mother was engaged in married women's labour—evidence was contradictory or refused.

In 11 cases of prolonged lactation (*vide supra*) the additional milk feeds employed were of sweetened condensed milk—no fresh milk was used.

B. 'Outer ring' cases. Total 108 cases (108 investigated out of 111):—

In 61 cases diluted fresh milk of good quality was given to the child with additional carbohydrate in the form of patent food.
In 14 cases, fresh cow's milk with additional sugar.
In 2 cases, fresh cow's milk with additional cream and sugar.
In 9 cases, sweetened condensed milk.
In 5 cases, diluted fresh cow's milk without extras.
In 17 cases of prolonged lactation (*vide supra*) the extras provided were as follows:—

  In 12 cases, fresh cow's milk with extra carbohydrate in the form of a patent food.
  In 5 cases, a limited amount of fresh milk—less than half a pint—with the general diet of the family.

APPENDIX 4. CHANGES IN THE COST OF FOOD AND OTHER COMMODITIES DURING THE PROGRESS OF THE INVESTIGATION

Monthly returns published by the Ministry of Labour.

		Food.	*Other Commodities.*	*Total index Number.*	*Increase or Decrease per cent.*
1920.	January	287·4	355·3	330·4	...
	February	273·3	377·0	340·9	+3·2
	March	293·3	386·9	352·6	+3·4
	April	301·2	382·8	352·9	...
	May	305·9	372·0	347·8	−1·3
	June	304·4	352·5	334·8	−3·7
	July	300·2	351·7	332·8	−0·6
	August	287·5	346·2	324·7	−2·4
	September	293·5	332·5	318·2	−2·0
	October	297·8	309·9	305·5	−4·0
	November	276·5	265·4	269·5	−11·7
	December	260·8	245·6	251·2	−6·8

		Food.	*Other Commodities.*	*Total index Number.*	*Increase or Decrease per cent.*
1921.	January . .	244·8	219·7	228·9	−8·8
	February . .	226·3	202·3	211·1	−7·7
	March . .	223·7	191·6	203·4	−3·6
	April . .	216·4	187·6	198·2	−2·5
	May . . .	206·7	185·0	193·3	−2·5
	June . .	205·2	176·0	186·7	−3·4
	July .	208·8	173·6	186·5	−0·1
	August . .	209·1	169·0	183·8	−1·4
	September .	187·8	176·7	180·8	−1·6
	October . .	175·1	169·4	171·5	−5·1
	November .	179·0	160·8	167·5	−2·3
	December .	168·1	158·8	162·1	−3·2
	Pre-war . .	100	100	100	

APPENDIX 5. MARRIED WOMEN'S LABOUR

On account of the necessity which prompts the applicant, married women's labour is the cheapest labour of all. The undermentioned details are from an out-patient notebook dealing with home conditions collected before the war between the years 1905 and 1914. There is no indication at the present day that the wage, though it is higher, has increased to any marked degree in its 'buying value' for the necessities of the home.

1. Mrs. F. 'Mantle making', machine work collected by the mother from a Southwark depôt for a City firm. Ten or twelve mantles or coats are finished weekly and ten or twelve shillings earned.

2. Mrs. C. Jar- and bottle-washing. Jam factory. Wages 10*s.* weekly. Hours, 8.0 a.m. to 7.0 p.m. Dinner hour 1.0 p.m. to 2.0 p.m., and tea 4.0 p.m. to 4.30 p.m. Work especially in January, February, and March before the summer jam season.

3. Mrs. E. B. Laundry hand. 10*s.* weekly.

4. Mrs. C. G. Collar stitching, linen. Three button-holes stitched. For twelve collars, 2¼*d.* paid.

5. Mrs. B. 'Mantle making'. Machine work in a work-room. 4½*d.* per mantle paid and worker 'finds own cotton'. Poor materials for third-rate goods. Can earn 8*s.* weekly.

6. Mrs. M. Laundry hand, ironer. Week days 9.0 a.m. to 9.0 p.m., less 1½ hours for meals. Saturdays 9.0 a.m. to 4.0 p.m., less half an hour. Average 60 hours per week. Wages 14*s.* weekly.

7. Mrs. A. D. Waitress, tea shop. Wages 10*s.* 6*d.* weekly. Teas are provided free and 1*s.* 6*d.* weekly is deducted for dinners if provided.

8. Mrs. A. Office cleaning in the City. Hours, 7.0 a.m. to 9.0 a.m., and 6.0 p.m. to 8.30 p.m. Wages 12*s.* weekly less travelling expenses.

APPENDIX 6.—TREATMENT

1. The great majority of cases of rickets found in a poor industrial district have been fed for at least two months upon some brand of sweetened condensed milk. The substitution of fresh cow's milk for the condensed milk in an early case of rickets is all the treatment that is necessary if the child is otherwise healthy, as is usually the case. An immediate improvement follows the change.

2. If the baby is only taking milk and no other food, a good guide is to feed at 40 to 50 calories per pound with undiluted citrated fresh milk, no sugar to be added. From an early age the great majority of babies will take this milk without any difficulty. The use of a dried cow's milk, without additional sugar, is also a successful, clean, and cheap method of working in a poor industrial district, and during hot weather in a large town it has a distinct advantage. The possibility of scurvy when working with dried milk is very remote if the milk is of good quality, and for all practical purposes the possibility of such failure can be eliminated by the use of a little fresh fruit juice.

A small percentage of babies suffer during early months from an inability to digest a milk containing 3 per cent. fat. They are often premature deliveries, or they were of small weight at birth and from the earliest days they make slow progress, exhibiting some form of primary infantile dyspepsia. As a rule an increasing tolerance for fat is acquired after the first few months, and an early attempt must be made by the doctor to restore the normal fat-carbohydrate balance which he has been compelled to alter during the early months of the child's life.

3. When the rachitic child is found to be taking a general dietary containing a marked excess of sugar and starch foods and very little fat or fresh milk, treatment must first be directed to the removal of the carbohydrate excess. This important point is often neglected, and the diet is further loaded with an increase of fresh milk with the addition of cod liver oil.

Parents readily admit that money will not allow them to buy fresh milk, but the excess of cane sugar which is spread upon bread and margarine and even added to sweetened condensed milk, the large amount of potato, and in some families the continual use of patent foods cooked with a small ration of milk, is only realized as the result of frequent visits to the home of the child.

The effect of limiting sugar and starch and of increasing the amount of fresh milk, perhaps to 1 or 1½ pints daily, is to lower the child's weight possibly by ½ or ¾ lb. during the first fortnight after the change in the diet. Thereafter, given the usual type of healthy child, there is a steady gain in weight which accompanies an increased precipitation of calcium, recognized by X-ray examination, and replacement of the watery, flabby fat characteristic of rickets by the firm fat and muscle of the normal growing child.

Unless first treatment is directed to the removal of the excess of carbohydrate, improvement is slow and irregular.

Many early cases show improvement simply as a result of thus partially rectifying the diet balance: no other treatment is required.

4. The use of malt extract for rachitic children.

Probably much of the reputation which malt extract has acquired as a food substance of value for rachitic children is due to the fact that the diet of so large a number is overloaded with carbohydrate food, and the diastatic value of the malt, if of good quality, appears to assist in the assimilation of starch foods. This certainly seems to be the case with infants suffering from primary dyspepsias who fail to thrive from birth and who are liable to show early X-ray signs of rickets between the sixth and eighth months of life.

During the second year of life malt extract is useful as a food, for 84·4 per cent. of the rachitic children when first seen are subnormal in weight. Much of the malt that is prescribed for hospital out-patients is merely used to disguise or 'cover' the taste of the cod liver oil which is the essential item of treatment.

5. If a case of rickets fails to improve when the adverse diet balance has been rectified and a satisfactory dose of cod liver oil is being taken by the child, not merely ordered, then an intercurrent infection may confidently be suspected. The following may especially be mentioned: latent tuberculosis, in particular tabes mesenterica, septic bronchitis, recurrent tonsillitis and naso-pharyngitis, latent empyema, pyelitis, chronic follicular ileo-colitis, and, at the present time more especially owing to a two-years' prevalence of scarlatina, chronic tubal nephritis.

All of these delays to recovery have been encountered during the course of 16 years' unpublished studies dealing with the different types of rachitic child.

6. Cod liver oil occupies the supreme position as a specific for the treatment of rickets.

Whether the matter be viewed from the point of view of cost (14*s.* per gallon, 1920 Norwegian cod liver oil, hospital contract price), or from the question of rapidity and certainty and completeness of cure, there is no other natural or artificial compound on the market which can compare with it.

At the present time there are a few artificial mixtures on sale advertised as containing 'anti-rachitic vitamines' (*sic*). One of these, provided gratuitously with great kindness by the manufacturers for the purpose of research in hospital, has been tested, in larger doses than advertised, against another rachitic child in the same Rotherhithe family who was receiving cod liver oil. Both children received the same standard diet under supervision in hospital. The child receiving the proprietary manufactured mixture or compound undoubtedly made improvement during six months, and at the end of that period the X-ray photographs showed definite signs of rachitic repair, the boy growing 2 in. and increasing 4 lb. in weight. His improvement, however, was not to be compared with that of his sister, who made most remarkable progress while taking full doses of cod liver oil.

The dose of cod liver oil commonly given to out-patient children who are attending hospital for rickets is very often far too small. Notes taken of the dose ordered at ten different hospitals or dispensaries for the sick poor, showed that the usual dose for a rachitic child of eighteen months or 2 years is one teaspoonful (=ʒij) of malt and cod liver oil, a mixture containing 20 to 25 per cent. of the oil, three times daily.

As mentioned above, malt extract is of questionable value or only of secondary importance in the active treatment of rickets, and the smallest dose of cod liver oil that may be considered adequate, if definite and rapid improvement is to follow, is two teaspoonfuls (=ʒiv) of a 50 per cent. emulsion given three times daily (= ʒvj pure cod liver oil daily).

In hospital much larger doses are soon tolerated, and if the cases of rickets be severe and of long standing, ʒiij of the pure oil three times daily (=ʒix) is a satisfactory dose with an average hospital diet for a child, containing one pint of fresh milk.

In a small ward of six cots, with efficient nursing, I have obtained the administration of far larger doses over considerable periods with great success for severe cases of rickets, the usual dose being 6 drachms of pure cod liver oil three times daily (2¼ fluid ounces daily) for children aged 3 to 5 years.

The case recorded is that of a child aged 4 years who came under my observation at that age, being one of four children with severe deformities in the same family.

The child in question, E. C., age 4, No. 320, was the most severe case of rickets in the whole series. The heights and weights are given below. There were severe deformities of both femora, of both tibiae and fibulae, with marked enlargement of the epiphyses of the long bones.

Every factor connected with the home, a two-roomed flat in a Bermondsey tenement building, was unfavourable, and delayed treatment and recovery.

The father was a casual labourer, more often unemployed than in work.

The notes on the home state : 'The rooms are dark and sunless, both light and air being shut out by another block of buildings. The rooms are clean and neat but very bare, the mother having been obliged to pawn most of their possessions while her husband was out of work '.

During the first ten months that this home remained under close observation an attempt was made, fairly successfully, to ensure a supply of 1 pint of fresh milk daily for the child E. C., and a regular dose of ʒiv of malt and cod liver oil three times daily.

During the ten months' observation in the home the weight, which was that of a baby twelve months old, only increased 2 lb. and the height increased only half an inch.

She was then admitted to hospital, and the dose of cod liver oil steadily increased until on the 23rd November, 1920, she was taking 6 fluid drachms of pure cod liver oil three times daily (total 2¼ fluid ounces daily).

This dose was continued daily for a year until 29th November, 1921. During that period she gained 10 lb. in weight and increased 5¾ in. in height.

The weights and heights at various intervals are given below, and also notes of the hospital diet which was her average intake daily.

The child was shown at a meeting of the Society of Medical Officers of Health (Infant Welfare Branch) on 15th December, 1921, and her excellent condition, characterized by firm fat and muscles, with marked improvement in the bones, which were much straighter and thicker, was the subject of general agreement.

There was no gross evidence at any time of undigested fat in the stools, which were of normal appearance always.

E. C. No. 320.

	Weight.	*Height.*
3 Dec. 1919.	20 lb. 6 oz.	29½ in. (4 years.)
24 Mar. 1920.	20 lb. 12 oz.	
6 Sept. 1920.	22 lb. 4 oz.	
6 Oct. 1920.	...	30 in.
15 Nov. 1920.	22 lb. 12 oz.	
31 Jan. 1921.	...	32¼ in. (5 1/12 years.)
15 Feb. 1921.	26 lb. 0 oz.	
3 May 1921.	28 lb. 12 oz.	
5 July 1921.	30 lb. 10 oz.	35 in.
21 Nov. 1921.	32 lb. 10 oz.	35¾ in. (6 years.)
12 Dec. 1921.	32 lb. 8 oz.	
6 Feb. 1922.	33 lb. 4 oz.	

Dose of Cod liver oil after admission to hospital.

From 13 Sept. 1920.	Emulsion ol. morrhuae (50 per cent.) ʒij T.D.S.
From 4 Oct. 1920.	Extract malt c̄ ol. morrhuae (25 per cent.) ʒiv T.D.S.
From 9 Nov. 1920.	Pure cod liver oil. ʒij T.D.S.
From 16 Nov. 1920.	Pure cod liver oil. ʒiv T.D.S.
From 23 Nov. 1920.	Pure cod liver oil. ʒvj T.D.S.
From 29 Nov. 1921.	Pure cod liver oil. ʒiij T.D.S to present time.

Note.—From 23 Nov. 1920 to 29 Nov. 1921 the daily dose of cod liver oil was ʒxviij.

Hospital diet.—Average taken daily in addition to cod liver oil ʒxviij from 23 Nov. 1920 to 29 Nov. 1921

	Per diem.	*Total.*
Bread. 1½ oz. three times (sometimes 2 oz.) at 80 calories.	4½ oz.	360 calories
Potato. 2½ oz. at 20 calories.	2½ oz.	50 calories
Vegetable. 1 oz. at 10 calories.	1 oz.	10 calories
Meat mince. 1½ oz. at 56 calories	1½ oz.	84 calories
Dripping. ½ oz. at 250 calories	½ oz.	125 calories
Rice pudding (standard), milk included	3 oz.	120 calories
Fresh milk, pasteurized	15 oz.	300 calories
Total	...	1,049
Cod liver oil	ʒxviij	600 calories
Grand total	...	1,649 calories

Weight, 32·5 lb. or *50 calories per lb.*

APPENDIX 7. UNEXPLAINED CASES, 9

1. D. B. No. 15. Baby girl. Age fifteen months. Rickets with deformities and marked enlargement of both radial and tibial epiphyses.

The baby was born at term, though of small size at birth. The child was breast-fed for ten days when secretion of milk failed, and the baby was bottle-fed with fresh milk and Ridge's food according to the advertised directions.

From nine months to fifteen months of age the total fresh milk given to the child daily without intermission has been ℥xxv to ℥xxx.

Four bottles given by day made up with one tablespoonful of sugar, one tablespoonful of food, and one pint of fresh milk. Two bottles are given by night, using an additional half-pint of milk with food and sugar in the same proportions. From the age of eleven months the child also received an occasional 'finger' of bread and margarine or dripping and a little potato and gravy. Signs of rickets appeared at the age of twelve months.

D. B. is the seventh child. The first four children, now aged 11, 10, 8, and 7 years respectively, were fed in a similar way with a similar quantity of milk, receiving about 1½ pints of fresh milk daily at the age of one year. None of them were 'fussy with their food' when a general diet was started. They have not developed signs of rickets, though they are subnormal height for age. The fifth and sixth children, aged 4 and 3 years, were war-time babies and suffered severely from the prevailing war-time shortages of milk and dripping. Both developed rickets. The sixth child, H. B. No. 14, in addition was given too much sugar, receiving far more than her share. It is said that 'she won't touch dripping, but she will eat sugar until further orders'.

The home is about 4½ miles from the river in a suburban district, close to a large park, with open surroundings. A six-roomed house, rent 11*s.* 2*d.* weekly, four rooms occupied including two bedrooms, two rooms being let.

The mother fed her seventh child who developed rickets in exactly the same way that she fed the first four children who were free from rickets. No explanation is offered.

2. G. B. No. 269. Baby boy. A full time delivery. The baby came under the notice of an excellent clinic at the age of fourteen days. He was breast-fed alone until the age of three months, when after consultation it was decided to wean him, as the child was not thriving. He was then fed by 'Glaxo' until the age of four months, when he was transferred to the Infirmary as his mother was admitted there for rheumatic carditis. The child remained in the Infirmary for five weeks, being fed on fresh milk, water, and sugar mixture. This was continued after discharge from hospital until he was eight months old, receiving constant supervision from a Welfare Centre. From eight months to nine months of age he had Savory and Moore's food made up with 'Glaxo' and 'Virol' ʒj. t. d. s. in addition. He made progress with this bottle, and at 9½ months a change was made to fresh milk, 1½ pints daily, and this remained almost his only food until the age of twelve months, when his weight was 18 lb. 10 oz. Dentition started at ten months (2 teeth), 11 teeth at seventeen months, 16 teeth at twenty-six months. Apart from a short attack of diarrhoea at the age of five months (August), and again for a brief period at thirteen months, there were no illnesses. First signs of rickets were noticed at the age of fifteen months; at the age of sixteen months he was admitted to the Nursery attached to the Welfare Centre and remained under supervision. The diet of the Nursery included fresh milk ℥xij daily, rice-pudding, a small portion including about ℥iij fresh milk, dripping about twice a week, bread and margarine, jam, and Lyle's syrup. Between the age of sixteen months and twenty-four months, when his weight was 24 lbs. 10 oz., the signs of rickets became more marked, the boy remaining under observation of the Welfare Centre. He subsequently made satisfactory progress.

The child's mother was ill with valvular heart trouble during her pregnancy, and in addition was short of food, owing to her husband's unemployment. The baby weighed 7 lb. 9 oz. at birth and 7 lb. 14 ozs. at fourteen days, from which time he remained constantly under supervision of an excellent Welfare Centre and a Nursery attacked to the Centre. From five months to eight months of age the baby did not thrive, gaining no weight, 13 lb. 6 oz. to 13 lb. 1 oz., but from eight months to fourteen months of age he did well, and the appearance of rickets during the second year was unexpected.

3. K. D. No. 238. Baby girl. Breast-feeding was employed until the age of five months; at that age as the child did not seem to be progressing, a bread sop made with water and a little sugar and fresh milk was given as an extra about four times daily, breast-feeding being continued. At six months the child was weaned, taken to an Infant Welfare Centre, and 'Cow and Gate' milk was ordered with 'Virol' in addition. The baby continued to make satisfactory progress until the age of ten months; after that date she had the run of the table, and though the dried milk was continued, it was given irregularly, and largely replaced by tea made with fresh milk. From the age of ten months onwards 'about a pint of fresh milk was used daily, sometimes not so much'. The child's appetite was good, 'she had no particular likes and dislikes', she looked well and seemed to be making progress but she was backward in walking, teething, and the fontanelle closed late; she was subnormal in weight and height. The child was born in September 1917. In spite of the war the mother does not consider that the family were short of fats—lard, dripping, butter, and bacon fat were obtained occasionally, and the child has exhibited no dislike for fat as an item of diet. No excess of sugar has been allowed. Early signs of rickets appeared at the age of eighteen months (March 1919) and deformities of the legs at the age of twenty-two months.

The home was a satisfactory house in Dartford, Kent.

The child made satisfactory progress as soon as additional fresh milk and cod liver oil were added to the diet, though she remained of subnormal height and weight. At $3\frac{7}{12}$ years 35 in. height. Weight, 26 lb. 10 oz. at $2\frac{9}{12}$ years, 29 lb. 8 oz. at $3\frac{2}{12}$ years.

There was no money wasted in the home, the children were well cared for, and 'money has been spent on food rather than clothes'.

4. M. E. No. 25. Baby girl. Age eighteen months. Prerachitic type early signs only.

Breast-feeding was employed for this baby until the age of one month and then the child was weaned. From one month to seven months of age bottle-feeding was employed, using fresh cow's milk and water in satisfactory proportions. When the child was seven months old 'Glaxo' was advised by a Welfare Centre owing to warm weather and the prevalence of summer diarrhœa. This dried milk, however, did not suit the baby, there was a tendency to vomiting and diarrhoea, so after three weeks' unsatisfactory progress she was brought to hospital and fed from the age of eight months to twelve months with undiluted citrated milk, the child making weight steadily. Very little solid food was possible before the age of twelve months, as the baby would vomit bread sop. After that date the diet included bread, margarine, dripping, and bacon fat, together with a pint of fresh milk. The child was fond of fat, and dripping was a regular item of the family's diet. She could not digest potato, though she liked it, potato producing colic and vomiting, so bread and broth or gravy was given in lieu. This diet was maintained until early signs of rickets appeared at the age of eighteen months. The tibiae became slightly bowed, the fœtal curves increasing. There was no enlargement of the epiphyses, and the early X-ray signs were checked by the addition of cod liver oil emulsion (50 per cent.) ℥j daily (=ʒiv Ol. Morrhuae) and a daily minimum of ℥xxv to ℥xxx fresh milk. Weight 26 lb. 8 oz., 16 teeth at twenty-five months.

The baby was very pale, the complexion at once suggesting insufficient fresh air. She was also a very nervous child, restless at night, with head-banging habits.

The house was one of the few visited where overcrowding was present; fourteen persons were living in four rooms and sleeping in two rooms. Basement and ground floors. Tenement building. Rent 10*s.* 6*d.* weekly. In residence eight years.

The following are the notes of the home in Southwark:—

Kitchen. Aspect NW. 12 ft. 10 in. × 17 ft. 2 in. × 8 ft. 6 in. height. Door to outside court 3 ft. 6 in. × 7 ft. 4 in. Window 3 ft. 4 in. × 4 ft. 11 in. The staircase leads from this room to a bedroom above.

Parlour. Aspect SE. 13 ft. 0 in. × 10 ft. 1 in. × 8 ft. 6 in. height. Window 3 ft. 5 in. × 4 ft. 11 in.

Bedroom 1. Aspect SE. 13 ft. 1 in. × 9 ft. 7 in. × 9 ft. 4 in. height. Window 3 ft. 0 in. × 6 ft. 0 in. Sleeping arrangements: The parents sleep in a double bed, M. E. sleeps in a cot, and three boys, age 6, 5, and 2½ years respectively, sleep in a single bed.

Bedroom 2. Aspect SE. 17 ft. 1 in. × 12 ft. 2 in. × 9 ft. 4 in. height. Window 3 ft. 0 in. × 6 ft. 0 in. The staircase leads from this room to the kitchen below, a door separating. There are eight children, four boys and four girls, sleeping in this room, the ages varying from a boy age 19 to a girl age 7 years. Four beds. A curtain divides the room, the window ventilating one half and the door the other.

Sanitation. W.C. on ground floor, outside bedroom no. 2, reached by going through a door into the open. Flush adequate. Window ventilation.

Cleanliness.—Fair, considering the size of the family. Bugs present.

Ventilation.—Fair.

Father age 47. Corporation City cleansing. Thirty years' service. Exempted army. Giving 50*s.* weekly. Three eldest children at work. Boy, age 19, clerk, giving 24*s.* Girl aged 18 and girl aged 16, making 'batteries', giving about 15s. each. *Income regular,* 104*s.* weekly.

Mother, age 43. A Southwark midwife. She has had sixteen pregnancies herself including fourteen full-time (two twin pregnancies) and two miscarriages.

Children alive, 12. Ages: 19, 18, 16, 14, 12, 11, 9, 8, $6\frac{1}{2}$, 5, $2\frac{1}{2}$, and $1\frac{6}{12}$ years.

Dead, 4, viz. two still-born at term and two died of summer diarrhoea in infancy.

Of these children alive, a boy, aged $6\frac{1}{2}$, has been treated for pleural effusion (diagnosis tuberculosis). He has previously received country home treatment for twelve months through the agency of the Invalid Children's Aid Association. A boy age 5 has been under treatment for rickets with deformities. He was born in 1914. None of the elder children were then in work, and the father was only earning sufficient wages to give his wife 25*s.* weekly. With this money the mother had to provide for nine children and meet a rent of 8*s.* 6*d.* weekly. She occasionally made a few shillings as an uncertificated mid-wife.

5. J. F. No. 193. A baby boy weighing 8 lb. at birth.

Breast-feeding was given alone for eight months, and breast-milk was subsequently continued, with two extra feeds daily consisting of Robb's biscuit, sugar, and fresh milk until the age of twelve months, when the child was weaned. From the age of twelve months a general dietary (war-time) including 1 to $1\frac{1}{2}$ pints of fresh milk daily was provided, and from the age of eighteen months the diet still contained one pint of fresh milk.

Deformity was first noticed, together with muscular weakness, at the age of eighteen months, and the deformity became more marked until the age of twenty-two months, though he was taking one pint of milk daily under supervision. After that date (April 1919) he made satisfactory progress.

Dentition.—First tooth at 14 months; 16 teeth at 2 years; 20 teeth at $2\frac{7}{12}$ years. Weights.—24 lb. 0 oz. at eighteen months; 30 lb. 4 oz at $2\frac{4}{12}$ years.

The diet used between the ages of twelve months and eighteen months was adequate, and there was no excess of cane sugar allowed. Exercise and fresh air satisfactory.

The mother is 'not strong'. For some years she has suffered from 'indigestion', but she states definitely that during the year that she was feeding the child with breast-milk she was quite well, and her old trouble returned after weaning. She did not suffer from food shortages during either pregnancy or lactation. Her age is twenty-five years. This is the only child, and there has been no other pregnancy.

The father is a healthy ex-service man aged twenty-seven years.

The mother's eldest brother suffered from rickets with deformities as a child, but there is no other case of rickets on either father's or mother's sides.

Both parents are tall. The boy's height was $36\frac{1}{2}$ in. at $2\frac{7}{12}$ years (stem 22 in.) and subsequently he continued to grow fast, reaching 40 in. height with stem height 24 in. at $3\frac{4}{12}$ years. His 'growth impulse' was certainly above normal.

6. A. G. No. 31. Baby girl. She was brought to hospital with well-marked rachitic deformities of tibiae, slight enlargement of epiphyses, and slight 'beading' of ribs at the age of twelve months. At that age she was a fat child of normal weight. There was no breast-feeding—the mother had no breast milk.

A. G. was bottle fed with fresh milk and water—equal parts with additional cane sugar—until the age of seven months. From that date bread-and-milk was given as an extra, the bread being first boiled in water, then strained, and milk and sugar added. At the age of nine months the child was taking one pint of fresh milk daily (April 1918), and milk pudding, also made with fresh milk, was a further addition to the diet. The fresh milk was always sweetened with cane sugar but never to excess; sometimes lime-water was used as a diluent. The child came under observation at the age of twelve months with well-marked signs of rickets, the X-ray appearances and deformity becoming more marked during the next two months when the child was receiving an ordinary war-time dietary without dripping or butter, but with one pint of fresh milk daily.

Throughout the pregnancy (October 1916 to July 1917) the mother was unable, or able only with difficulty, to obtain sufficient food for herself, but the baby was of normal weight at birth and made good progress to the age of nine months with the diet detailed above.

The child subsequently made satisfactory recovery, taking ℥ xxx fresh milk daily and two teaspoonfuls (=ʒ iv) of malt and cod liver oil thrice daily. She continued to grow fast. At $2\frac{6}{12}$ years the height was 36 in.; stem height 21 in.; and at $3\frac{5}{12}$ years the height was 39 in.; stem height $23\frac{1}{4}$ in.

The child's 'growth impulse' was certainly above normal.

The home was a satisfactory one in the suburbs—Tooting.

Subsequent note.—Control.—Younger child born April 29, 1920; hand-fed under supervision of a Welfare Centre with fresh milk, lime-water, and 'Virol'. No signs of rickets at seventeen months. Height at eight months, $28\frac{1}{2}$ in.; stem, $19\frac{1}{2}$ in.

7. F. J. No. 417. A baby boy. A premature delivery at $7\frac{1}{2}$ months. Weight at birth was 7 lb., and at the age of twelve months 'a heavy baby'. Breast-feeding alone was employed until the age of one month, when the father died and no breast-feeding was possible after six weeks. The baby was bottle-fed, using fresh milk and barley water in suitable proportions. At the age of four months he was taking 1 pint of fresh milk daily and $1\frac{1}{2}$ pints daily at the age of twelve months. Up to the age of eighteen months the child was never short of fresh milk, and sweetened condensed milk was only used very rarely if the milk had soured.

Extras were started at the age of seven months, bread and milk once daily. At eight months he was given a little mashed potato with margarine or dripping and a little thin-cut bread and margarine. At ten months, fresh milk pudding, and a general diet after the age of twelve months. His appetite was always excellent, and he continued to do well until the age of eighteen months. Dentition was not delayed, the first tooth appeared at eight months of age. He began to walk with help at the age of twelve months.

After the age of eighteen months he had a general dietary including half a pint of fresh milk to drink, with about ℥v in fresh milk pudding, and a generous dietary in addition, including butter, margarine, or dripping.

Signs of rickets appeared at the age of twenty-one months, the radial epiphyses became enlarged and the tibiae became bowed. His appetite remained good, his weight at 2 years of age was 29 lb., and he continued to grow. At $2\frac{3}{12}$ years his height was $34\frac{1}{2}$ in. Weight, 31 lb. 4 oz.

In spite of a severe infection with measles and broncho-pneumonia at the age of $2\frac{6}{12}$ years, his growth did not slow, though his weight remained stationary. At $2\frac{10}{12}$ years his weight was 32 lb., he was much stronger, the bones were becoming thicker and straighter. At $3\frac{2}{12}$ years his height was 39 in., stem height, 24 in. 'Growth impulse' above normal. His appetite remained excellent, the dietary adequate, including three-quarters of a pint of fresh milk daily. Satisfactory progress subsequently maintained.

8. A. J. M. No. 426. Baby boy. An illegitimate child. The mother remained at work as a packer in a provision store until the pregnancy had proceeded to seven months. Her general health remained good, and she was not short of food or money. The baby was breast-fed alone until the age of six months, and breast-feeding was subsequently continued until the age of nine months, when the child was weaned. From the age of six months two extra feeds were given daily, one of fresh milk and one of bread and milk. From the age of nine months he received 1 pint of fresh milk daily and a general diet including bread and butter, potato and gravy, bacon fat, occasionally a little fish or an egg. No condensed milk was used.

At the age of twelve months he appeared plump and strong. He had 5 teeth. He started to walk at the age of eleven months.

At the age of fourteen months early rickets was diagnosed. Weight, 18 lb. 8 oz. The child exhibited no intolerance for fat and he ate fat readily; fresh milk 1 pint daily minimum was taken regularly. He remained under observation.

At the age of fifteen months, he had only 6 teeth, the appetite was poor, there were profuse head sweatings. He could only crawl and could no longer stand without help.

At the age of sixteen months (August 1919) he suffered from 'summer diarrhoea' for about a fortnight. Weight, 18 lb. 10 oz. At nineteen months he had 10 teeth. He was receiving the same diet with 1 pint of fresh milk. Signs of rickets became rather more marked, the epiphyses became enlarged, and the tibiae became bowed. From the age of twenty months he progressed slowly.

At twenty-two months of age the weight was 21 lb. Height, 29 in. Stem, 18 in. He was still unable to walk. 1 pint of fresh milk was still continued. Butter, $1\frac{1}{2}$ to 2 lb. weekly, was a constant item of diet for the table of four adults and two children. 14 teeth had irrupted, poor enamel. No 'rosary' was present, though it had been previously recognized at the age of fourteen months. Muscular weakness persisted.

During the next year he made very little improvement. The mother returned to work, but then lost her employment, as did also an uncle, whose income was a most important asset of the home. The boy's milk supply became irregular. Height, 32 in. Stem, 19 in. at $2\frac{5}{12}$ years. 18 teeth. Money troubles arose, and the food of the family was of poor quality.

Though the failure to make progress was easily explained by the unemployment of the wage-earners, the onset of rickets between ten months and fourteen months of age could not be accounted for.

The father was a French Canadian, killed on active service. Said to have been a healthy man. There was no family history of rickets on the mother's side.

The child's diet was satisfactory and his appetite was good during the first year.

One of the uncles was employed at a chocolate factory, and the visitors of the Welfare Centre reported that chocolate and other sugar sweets were often seen in the home, but the mother did not admit that the baby A. J. M. received sugar in excess, nor did repeated examinations of the child suggest that he belonged to a type fed with a large quantity of sugar and starch food.

9. L. P. No. 58. Baby girl. No breast-feeding was possible, there was no breast-milk. The mother remained quite well during her pregnancy except for worry and fright during the prevalence of air-raids, which seem to have disturbed her more than most of her neighbours.

L. P. was apparently a full-time baby, weighing only 6 lb. at birth. The child was bottle-fed from birth with fresh cow's milk and barley water until the age of fifteen months; the total of fresh milk at that age was $1\frac{1}{2}$ pints daily, and up to that date, except for an occasional crust or Robb's biscuit, practically nothing else was given.

'She has always been a thin child, and her food did not seem to satisfy her.' A quiet, contented baby, who has never been taken to a Welfare Centre.

Well-marked signs of rickets with severe deformities developed during the second year after the age of fifteen months when the child was receiving a general dietary with 1 pint of fresh milk daily.

For general purposes in the home, skim condensed ('Goat brand') milk is used since the rise in price of fresh milk (8*d.* to 1*s.* per quart).

For a family of two parents and five children 13, 11, $7\frac{1}{2}$, 5, and 2 years, $4\frac{1}{2}$ lb. of sugar and 2 lb. of jam are obtained weekly (July 1920). The four elder children, who were fed in exactly the same way during the first year of life, are now strong, healthy, and well-grown children, and they have never shown signs of rickets.

L. P.'s weights: 17 lb. 8 oz. at $2\frac{3}{12}$ years, 21 lb. at $2\frac{9}{12}$ years.

Heights: $28\frac{3}{4}$ in., stem $18\frac{1}{4}$ in. at $2\frac{3}{12}$, height 32 in., stem $19\frac{1}{2}$ in. at $3\frac{1}{12}$ years.

12 teeth at $2\frac{3}{12}$ years, 16 teeth at $2\frac{9}{12}$ years. The fontanelle closed at 3 years of age.

Signs of rickets became much more severe after the child received the general house diet. The home was quite satisfactory.

The father was in regular work as a telegraph linesman (G.P.O.).

APPENDIX 8

Blank Schedule. Indicating the headings under which information was collected and tabulated:—

Name. Sex. Age.

Address.

Mother's age. Pregnancies—full time, premature, miscarriages.

Children—alive. Ages. General health.

Children—dead. Cause of death, age at death.

Father. Age, occupation, regular work—full time or part time.
Casual labour. Pensions. Unemployment. Money given to mother for housekeeping purposes.
Mother. Living at home. Whole time work. Part time work. Mother's wages if at work. Her health before and during pregnancy and during lactation. Other illness.
Family History. Diathesis.
Details of the home.
Approach. Back premises and surroundings.
Type. Separate house. Rooms in a house. Flat. Tenement flat.
Situation. Basement, ground floor or higher floors.
In residence for:
Lodgers or not.
Sanitation. W.C. Flush in order. Well kept or otherwise. Situation.
General cleanliness.
Ventilation. Aspect. Sunshine or not.
Total rooms in house. Number of persons.
Total rooms occupied. Number of persons. Sleeping arrangements.
Air-space of all rooms occupied. Air-space per person.
Air-space of sleeping room. Air-space per person.
Window-space of all rooms occupied.
Rent, and rent increase.
Other weekly payments: Fuel, gas, insurances, club subscriptions, debts outstanding.
General observations.
Reports from Welfare Centre, I.C.A.A. or C.O.S.
Notes of the Case under observation.
Method of feeding from birth.
General condition at birth. Delivery at term or premature.
Intercurrent infection. General progress.
Clinical notes. Dietary. Treatment.
Records of height and weight.
Health of other children in the family.

APPENDIX 9.

The following details of the composition of certain Infant Foods mentioned in the foregoing pages are taken from a table in *Food and the Principles of Dietetics*, by Robert Hutchison, M.D., F.R.C.P. (3rd edition, Arnold).

Allenbury No. 1. For children below the age of three months. Desiccated cow's milk from which the excess of casein has been removed and a certain proportion of soluble vegetable albumin, milk sugar and cream added. No starch present. Half an ounce in three ounces of water for a child aged three months. Percentage composition: Proteids 9·7, fat 14·0, carbohyd. 66·85, mineral matter, 3·75, water 5·7.

Allenbury No. 2. For children of the age of from three to six months. Resembles Allenbury No. 1 but contains some malted flour in addition. No starch present. One ounce in six ounces of water for a child aged six months. Percentage composition: Proteids 9·2, fat 12·3, carbohyd. 72·1, mineral matter 3·5, water 3·9.

Allenbury No. 3. A mixture of wheat flour and malt. When prepared according to the directions it still contains some unaltered starch. Designed for children above the age of six months. One tablespoonful (about one ounce), a teaspoonful of sugar, and three tablespoonfuls of cold water; mix and add half a pint of boiling milk and water (equal parts). Percentage composition: Proteid 9·2, fat 1·0, carbohyd. 82·8, mineral matter 0·5, water 6·5.

Ridge's Food. A baked flour containing only 3 per cent. of soluble carbohydrates, the remainder being starch. Recommended to be made with milk or water. Made with water alone is totally insufficient food. Percentage composition: Proteids 9·2, fat 1·0, carbohyd. 81·2, mineral matter 0·7, water 7·9.

Neave's Food. A baked flour similar to Ridge's Food, but recommended to be made with milk and water. Percentage composition : Proteids 10·5, fat 1·0, carbohyd. 80·4, mineral matter 1·6, water 6·5.

Savory and Moore's Food. Composed of wheat flour with the addition of malt. When prepared according to directions, most, but not all, of the starch is converted into soluble forms (chiefly dextrins). One or two tablespoonfuls (equals from one ounce to two ounces) to be mixed with two or three tablespoonfuls of cold milk or milk and water, and ⅓ pint of boiling milk or milk and water to be added. Percentage composition : Proteids 10·3, fat 1·4, carbohyd. 83·2, mineral matter 0·6, water 4·5.

Milo Food. A mixture of desiccated Swiss milk, baked wheat flour, and cane sugar (30 per cent.). Contains about 15 per cent. of starch. Percentage composition: Proteids 14·0, fat 5·2, carbohyd. 75·3, mineral matter 1·9, water 3·6.

Sweetened condensed milk (*Nestlé's*). A recent analysis, June 1921 (F. E. King, B.Sc., F.I.C.), gives: Total solids 76·0 per cent., including: Proteids calculated from nitrogen 8·93, fat 10·4; milk sugar 13·0, cane sugar 40.3, ash 2·10, acids calculated as lactic acid 0·5. Free from boracic preservative. During the process of manufacture cane sugar is added to the heated milk and the mixture is then condensed by boiling under reduced atmospheric pressure. The dilution of this condensed product, as practised by the purchaser, varies greatly (*vide* p. 42).

Skimmed condensed sweetened milk (*'Goat' Brand*). A recent analysis, June 1921 (F. E. King) gives: Total solids 71·85 per cent., including—Proteids calculated from nitrogen 10·45, fat 0·40, milk sugar 15·11, cane sugar 41·52, ash 2·75, acids calculated as lactic acid 0·78. Contains a trace of boracic preservative. This form of condensed milk is used among the poorest families (*vide* p. 42).

'Glaxo.' A dried milk from pasture-fed cows. It has the composition: Fats 25·5, proteids 22·9, carbohydrate 41·9, mineral matter 5·5, moisture 3·2.

'Ambrosia.' Another dried milk manufactured by a similar process and of very similar composition.

ACKNOWLEDGEMENTS

The original work which was undertaken in connexion with rickets was made possible owing to the action of the Committee of Management of the Evelina Hospital for Children, who placed funds at my disposal for the purchase of fresh milk on behalf of necessitous mothers and infants of the Southwark and Rotherhithe districts in South London. A Lady Visitor was also provided to superintend the relief and to report upon the condition of the homes.

This policy was continued when I started work for the Medical Research Committee in 1914, and permission was obtained to open a clinic for the observation and treatment of rickets, the hospital authorities providing the nursing staff, the facilities of the hospital dispensary and other details required for a large out-patient department.

In 1919 when the work was resumed after the war further help was obtained from the House Committee of Guy's Hospital, who gave leave for the investigation to be continued there as well. This co-operation was made possible through the great kindness of my friends on the staff of Guy's Hospital, who allowed me to examine and collect information concerning the cases of rickets attending their out-patient services. In particular I am indebted to: Dr. H. W. Barber, physician to the Skin Department, Dr. H. C. Cameron, physician to the Children's Department, Mr. T. B. Layton, surgeon to the Throat Department, and Mr. W. H. Trethowan, surgeon to the Orthopaedic Department. This extension of the field of work allowed a rapid collection of cases which could be studied before there was any appreciable change in the economic conditions.

From Dr. G. B. Milson, Medical Officer of Health for Southwark, and from Dr. R. King-Brown, Medical Officer of Health for Rotherhithe, much help was obtained in the provision of milk for necessitous mothers and for the children

of those homes where the wage-earners were unemployed or in temporary difficulties owing to illness. No delay was experienced in obtaining help for urgent cases under these conditions, and there was every indication that the control of relief work of this character was in capable hands in both Southwark and Rotherhithe.

By permission of the Superintendent of Lambeth Infirmary I was able to examine and obtain details of some interesting cases of rickets in that institution, Dr. G. F. Stebbing, Senior Medical Officer, and his colleagues giving valuable help to the investigation.

I am much indebted to the Medical Officers of a great many Welfare Centres in South London who sent cases of rickets and other forms of malnutrition in childhood to the Evelina Hospital for the purpose of diagnosis and treatment. Many interesting and unusual cases were added to the records in this way. I was also enabled to visit several of the Welfare Centres and examine the children in attendance, besides obtaining information of local industrial conditions.

The Medical Research Council provided me with the help of three expert Lady Visitors:

Miss Evelyn J. Densham, R.R.C., formerly Assistant Matron, Guy's Hospital.
Miss Joan Lyons, R.R.C. formerly Sister Mary, Guy's Hospital.
Miss Hilda M. Vine, formerly Sister Charity, Guy's Hospital.

In addition to an expert knowledge of nursing and social work, they are endowed most happily with an immense capacity for tact and friendliness, which has been responsible for the complete records of house-to-house visiting as well as for the efficient maintenance of working relationships between home, Welfare Centre, and hospital.

February, 1922.

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MEDICAL RESEARCH COUNCIL

(Formerly Medical Research Committee, National Health Insurance).

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December 1922

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The Amoebae living in Man. By Clifford Dobell. Price 7s. 6d. net. [Bale, Sons & Danielsson, Ltd.]

The Intestinal Protozoa of Man. By Clifford Dobell, and F. W. O'Connor. Price 15s. net. [Bale, Sons & Danielsson, Ltd.]

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